REPORT TO CALIFORNIA TOLL BRIDGE AUTHORITY
ON THE
BRIDGE RAILWAY
SITUATION ON THE
SAN FRANCISCO-OAKLAND BAY BRIDGE

OCTOBER 1954

DIVISION OF HIGHWAYS
DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA

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October 1, 1954

PLEASE REFER TO
FILE NO.

Mr. Frank B. Durkee
Director of Public Works
State of California

In compliance with the request of the California Toll Bridge Authority, contained in its resolution of July 1, 1953, it is my pleasure to submit herewith for your approval and transmittal to the Authority an Engineering Progress Report on alternative plans for the future utilization of the space occupied by the bridge railway on the San Francisco-Oakland Bay Bridge.

G. T. McCOY
State Highway Engineer

Enc.

700.261 BB Railway

October 1, 1954

Mr. G. T. McCoy:

Attached is a report which presents our analysis of data collected to date in connection with practicable procedures for handling mass transit over the SF-O Bay Bridge. On December 2, 1953, a progress report on the Bridge Railway Studies was forwarded to the Director with your memo of December 7. As stated in that report these studies are being carried on in accordance with the resolution of the Toll Bridge Authority, dated July 1, 1953, which requested the Department of Public Works to study the future of the Bay Bridge Railway in the event that the Key System was permitted to discontinue its own rail operations.

Our studies have reached a point where it is inadvisable to proceed further with more detailed plans until the Bay Area Transit Commission and others who are now studying the area-wide mass transit problem have reached a conclusion - at least with respect to the function of the Bay Bridge Railway in the general mass transit system. Therefore, opinions and comments regarding the various alternative plans are offered only to assist in arriving at the final decision as to the plan and how it can be accomplished. This report has been prepared by the Bridge Department of the Division of Highways, the information being collected and analyzed by R. M. Barton, Associate Bridge Engineer under the direct supervision of Stewart Mitchell, Bridge Engineer, Special Studies.

The report on the Bridge Railway by Coverdale and Colpitts, dated May 15, 1953, which was presented to the Toll Bridge Authority on July 1st, specifically referred to the possibility of continuing rail service over the bridge by the operation of a shuttle service between the present San Francisco Terminal and a terminal in the East Bay Area on the mole or in the vicinity of 40th and San Pablo Avenue and concluded that estimates of cost and time involved in these possibilities should be prepared.

Further studies have confirmed our belief, as stated previously, that such a shuttle service is not practical even as a temporary measure. It seems evident that it would result in a diversion from mass transit to private automobiles that would cause more congestion on the vehicular portion of the bridge than if all mass transit patrons were handled in buses. From the standpoint of alleviating traffic congestion it would be better

to leave the rails standing idle than to attempt to operate such a stop-gap rail shuttle service. The difficulty, of course, is that to leave half of the lower deck of the bridge unoccupied for any length of time would subject the Toll Bridge Authority to serious criticism, since few are in a position to appreciate the complexity of the situation.

As pointed out in our previous progress report, any feasible plan, whether it be continuation of rail service or conversion of the rail section to a vehicular roadway, requires a considerable expenditure. Not less than $12 million and perhaps as much as $30 million may be necessary as a minimum to implement any acceptable solution to the transbay transportation problem; the cost will depend on which plan is adopted.

At the present time no decision has been reached as to how these funds can or should be raised. It may be legally possible to finance the rail service by revenue bonds based on Bay Bridge tolls but it will involve matters of general policy and correlation with other projects which have been and may be proposed for financing from the Bay Bridge earnings.

There is also a question as to whether operation of a transbay rail service in cooperation with local city bus lines should be under the jurisdiction of the Toll Bridge Authority, a local public body or some transit authority. There is little hope that a private organization, such as Key System, can finance the necessary improvements to a rail system which will make it attractive to the public. Operation of the present slow-moving, surface track operation with antiquated equipment can only result in continued diversion from public transit to privately owned vehicles, with additional congestion on the vehicular roadways.

Since it is evident that some public agency must finance the construction of needed improvements and, perhaps, must handle the operation of the transbay service, it seems that a solution to this phase of the problem should not, and need not await the complete findings of the Rapid Transit Commission. Key System officials have indicated their intention to ask for a change to transbay bus operation within a couple of years and if they can present a workable plan, particularly with regard to loading facilities in San Francisco, the PUC would probably feel obligated to permit the change to be made on the basis of economy and service under present conditions. It is likely this will

occur before the studies now being carried on are completed and an agreement reached satisfactory to all interests in the Bay Area.

We believe it difficult to justify abandonment of the present rail facilities, which are valued at some $25 million, since it is the potential means of carrying more people between the downtown sections on each side of the Bay than any other form of transport. If a costly new facility had to be built, such as the tube recommended by the Army-Navy Board, then the economy of a rail facility might be subject to more question.

We also believe that rail service on the bridge could be made to pay at least its cost of operation if its track facilities and equipment are improved to modern standards. Such improvements include extending the Railway lines on separated rights of way to important focal points, say, downtown Berkeley, downtown Oakland, and perhaps the Piedmont Area. It also calls for the purchase of modern equipment. The cost of this naturally depends upon how many such lines are built, how far they are extended and how much new rolling stock is acquired; it should be a matter of $15 million to $20 million at least. If the operation is successful and the need apparent, further extensions can be made in the future.

F. W. Panhorst

Attch.

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on

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on the

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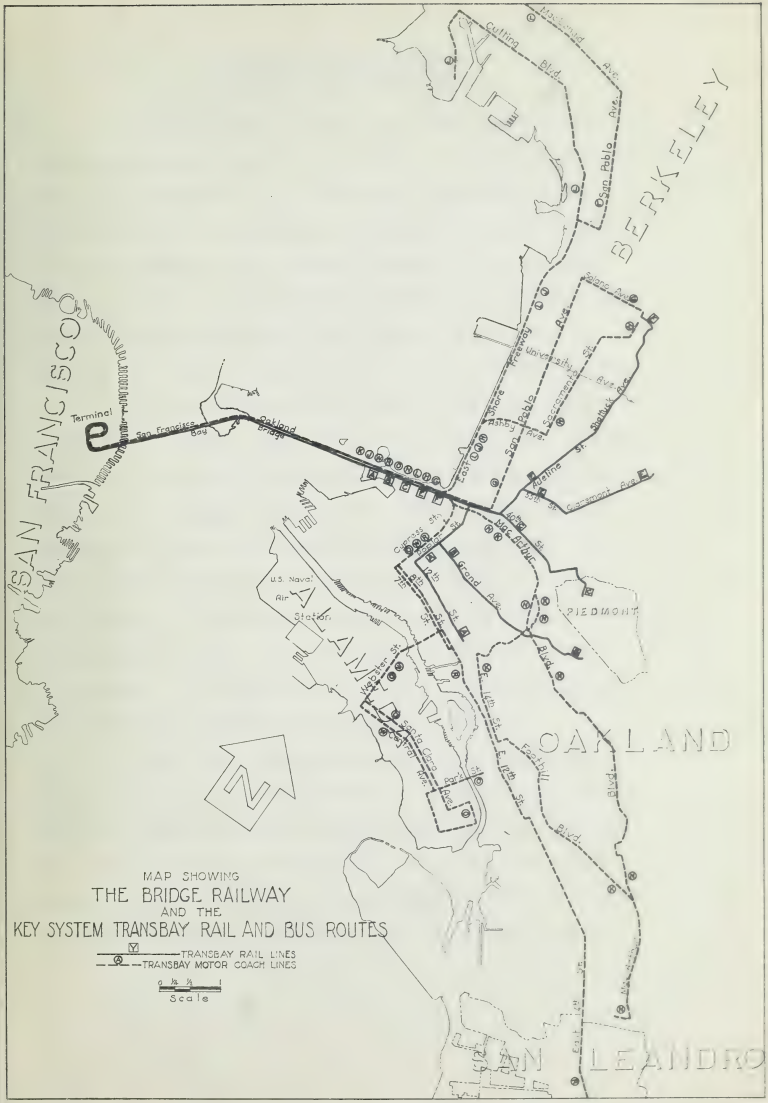
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Oakland Bridge
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Stone Ave.
University Ave.
Sacramento St.
Shattuck Ave.
Claremont Ave.
Telegraph Ave.
Grand Ave.
Lake Shore Ave.
PIEDMONT
U.S. Naval Air Station
ALAMEDA
Webster St.
Santa Clara Ave.
Park St.
Encinal Ave.
Webster St.
E. 14th St.
E. 12th St.
E. 10th St.
Foothill Blvd.
OAKLAND
SAN LEANDRO
MAP SHOWING
THE BRIDGE RAILWAY
AND THE
KEY SYSTEM TRANSBAY RAIL AND BUS ROUTES
TRANSBAY RAIL LINES
TRANSBAY MOTOR COACH LINES
Scale

FOREWORD

The patronage of the rail lines operated by Key System Transit Lines has steadily declined ever since the end of World War II. As a result of this the Key System, in 1952, petitioned the Public Utilities Commission for permission to abandon service on the "A" and "B" rail lines. It was generally felt that this was the first step leading toward the ultimate abandonment of all the rail lines connecting with the Bay Bridge railway.

At the meeting of the California Toll Bridge Authority on July 1, 1953, Coverdale & Colpitts presented a "Report on the Bay Bridge railway of the San Francisco-Oakland Bay Bridge" dated May 15, 1953. At the same meeting the Authority resolved that the Department of Public Works be requested to study and make a report with regard to the future use of the Bridge Railway in case the Key System rail lines were discontinued, and to consider the question of a shuttle service which was one suggestion made by Coverdale and Colpitts.

Many local committees and public bodies are studying the general mass transit problem and the San Francisco Bay Area Rapid Transit Commission has retained the firm of Parsons, Brinckerhoff, Hall and McDonald to make a study and prepare a comprehensive plan. The study is under way but no conclusions as to the future use of

the Bay Bridge Railway are expected for some time. Hence, it is not possible at this time to make definite recommendations as to the future use of the area on the Bridge now occupied by the rails which should ultimately become an integral part of the area-wide system. Therefore, this report has as its purpose the collection and study of available information relative to all the practicable types of transport by which persons may be taken across the bridge. In presenting this information it discusses the merits of each plan and considers the general area-wide mass transit system only as it may affect the operation of bridge traffic.

While final conclusions or recommendations affecting the Bridge Railway must await the findings of those who are studying the general problem of mass transit in the Bay area, it is evident from a consideration of the facts presented that any feasible plan, whether it be continuation of rail service or conversion of the rail section to a vehicular roadway, will require not less than $12 million and perhaps as much as $30 million to implement any acceptable solution to the transbay transportation problem, the cost depending on the plan adopted. Furthermore, it will take several years to complete the work.

Spending further time on detailed plans for any of the possible methods is not warranted until a

decision is reached as to which of two basic methods of transportation will be adopted, which are:

(1) Removing the rails from the bridge and repaving the area now occupied by the tracks for rubber-tired vehicles.

(2) Continuing the use of the bridge railway as a trunk line which will be an integral part of a modern rapid transit system.

Studies made so far indicate that an interim shuttle service without rapid transit feeder lines would not reduce traffic congestion on the bridge and would probably be operated at a loss. A terminal at 40th and San Pablo or at some other point near the east end of the bridge railway has been previously considered by others and the concensus is that it would not attract enough patrons to reduce vehicle traffic below that which would occur if all these patrons were transported in buses. (The loss of 10% in passengers as estimated by Coverdale and Colpitts would, if all traveled in automobiles, generate more congestion than the additional bus traffic necessary to carry the same number of passengers.) It is also evident that the present type of rail service which operates over busy East Bay streets will not attract patronage and will continue to cause a diversion of present patrons from the Bridge Railway. At present the Railway does little to alleviate vehicular

congestion on the bridge and it serves in no way to reduce the cost of transbay transportation.

With the general decline in mass transit patronage, particularly on the rails, and with the ever increasing vehicular congestion it is evident that transbay transportation is facing a critical period. After a decision has been reached as to the part the Bay Bridge is to play in an area-wide mass transit system the preparation of plans, overcoming legal obstacles, acquisition of rights-of-way and many other time-consuming operations must be overcome before actual construction can take place. At the present time there is no certain means of financing the construction of even a partially completed or interim system nor is there any agency in a position to handle its operation and maintenance. It is evident that neither Key System nor any other private corporation can be expected to undertake the improvements to the rail system which are necessary to attract patronage and obtain sufficient revenue to pay even the cost of operation.

Fundamental Considerations

Transbay transportation service is a public utility which involves the use of private automobiles and public conveyances--trains and buses. From the standpoint of the Bay Area as a whole the most economical solution to the transbay transportation problem is provided by whichever means will permit the largest number of people

to be carried across the Bay at the least overall cost and in the shortest practicable time. In other words, the following factors must be considered:

1. Capacity. The system should have ample capacity for probable future transit needs during a foreseeable service life.

2. Cost. Other things being equal, that system is the most desirable which permits its essential function of transbay transportation to be performed at least cost.

3. Time of Travel. If a mass transit facility is to be successful it must offer service that can compete in terms of convenience and travel time with private automobiles.

Alternative plans should be evaluated primarily on the basis of these criteria, not on the basis of maximum revenue or permitting the largest number of private automobiles to cross the bridge. Regardless of the plan selected, until additional transbay roadway capacity becomes available on new Bay crossings it will be physically impossible for all commuters to cross the Bay in their private automobiles. Some must either use mass transit or rearrange their affairs so that transbay trips are not required.

Comparative Merits of Transbay Rail vs. Bus Transit

A decision as to the future means of public transportation across the bridge should take into consideration the comparative merits of rail vs. bus which are summarized as follows:

Capacity to Meet Immediate Needs - If the area occupied by the rails is completely decked over, all public transit would then be by bus. For the present and the immediate future, any transit system which will provide seats for about 10,000 persons in one direction in the peak hour will satisfy mass transit demands. This load could be handled by upwards of 200 buses without seriously overtaxing the vehicular facilities if the space now occupied by the rails is paved and proper approaches are constructed. There would actually be some immediate benefit with respect to auto traffic.

Safety - In general the Bridge Railway trains offer a service which cannot be excelled insofar as safety is concerned. Due to the elaborate interlocking arrangements and the automatic safety cab controls installed in the present rail cars, it is practically impossible for an accident to occur on the Bridge Railway. No one has been killed or seriously injured in a train accident on the Bridge.

On the other hand, bus transit is subject to all the perils of highway travel. Several people have been killed or injured in bus accidents on the bridge and its approaches. For instance, there were 10 accidents involving buses in 1951 and 12 accidents in 1952. Of these 22 accidents, 10 involved Key System buses and the other 12 were distributed among military buses, Greyhound, Gray Line, Santa Fe and Beninger. A Key System bus accident which occurred on Tuesday, February 19, 1952, resulted in death to two persons and injury to 9 others.

Ability to Meet Future Transit Needs - Continuing diversion from public transit to private cars, if buses are the sole means of transbay public transportation, would soon fill up the new lanes afforded by the widened roadway. The loss of transit patronage with a corresponding increase in automobile traffic would probably amount to about 2000 additional autos in the peak hour in one direction in less than 5 years if there is space on the bridge and at their destination. Increasing vehicular traffic and diversion of automobiles to the lower deck will cause traffic tie-ups on the lower deck operating with mixed traffic and probably destroy the effectiveness of transbay bus transit at the time it is most needed, that is, at peak hours. Thus, there may be little if any increase in the total number of persons who can cross the bridge and the expenditure for redecking would prove useless from the standpoint of enabling more persons to cross the Bay.

But even if worsening congestion on the lower deck of the bridge did not enter the picture, there are indications the decline in transit patronage would continue. In recent months the slump in bus patronage has been almost identical to that of the rails. The proposed substitution of buses for trains on the remaining rail lines will not materially alter the physical characteristics of the service.

Rail transit, on the other hand, is unaffected by traffic congestion and the capacity of the Bridge Railway to handle transbay passengers is practically unlimited. The improvements discussed in this report should arrest the present decline and perhaps restore some of the lost patronage to the rails. Based on experience elsewhere, the potential increase in patronage might be as much as 50% over that carried on the rail and bus lines in 1952.

Ability to Compete with Automobiles - Buses offer few advantages as compared with automobiles. By its very nature the bus will always require as much time if not more for the same trip using the same highways as a private car. Even though more freeways in the approach areas are now being built, the increasing problem of congestion means that the overall time of travel by bus may increase instead of decrease as the years go by.

The fact that bus transportation is not the final answer to transbay transportation problems is indicated by comparing transbay and the peninsula transit with that of Marin County. Both the Peninsula and the East Bay have bus and rail connections to San Francisco, but Marin County depends entirely on buses for public transit service. Perhaps it is significant that the percentage of commuters now using automobiles in preference to public transit is higher in Marin County than for either the East Bay or the peninsula.

Speed - The rail equipment now used is much slower than the buses, which overtake and pass the trains on the bridge. Although the time differential is not great, the psychological factors cannot be ignored. However, new rail equipment should reverse the speed differential between the trains and the buses.

Frequency - Frequency of service is of particular importance in developing mass transit patronage. The existing rail transit patronage falls far short of justifying use of the present 132 seat articulated rail units. During off-peak hours Key System cannot economically justify more frequent service than that provided by up to 45 minute headways.

On the other hand, the more economical operation possible with the smaller buses allows more frequent service. Increased frequency of service on the present Key System rail lines, could only be considered economical if smaller, one-man rail equipment could be used.

Flexibility - Flexibility of service, to permit rerouting and extending lines to outlying areas, is a desirable feature. The high cost of extending or rerouting rail lines indicates the superiority of buses in this respect.

Dependability of Service - Since the Bridge Railway is an all-electric operation on separate right-of-way it offers the utmost in dependability of service. Buses, on the other hand, are subject to delay due to traffic tie-ups. In this respect, therefore, the trains on the Bridge have a marked superiority but not on the East Bay lines.

Effect on Parking Conditions in San Francisco - As previously stated, if Key System goes to all-bus operation, there is no reason why the trend in decline of mass transit patronage will be halted and this means more private automobiles from the East Bay seeking parking space in San Francisco. This trend would increase the parking demand in San Francisco in about 5 years by about 7,000 spaces, not all of which, however, would be occupied for the entire day. The cost of providing parking space for 7,000 cars is estimated to be on the order of $10 million.

On the other hand, improved rail transit service could possibly have a marked effect on the San Francisco parking problem. If the 1952 commuter patronage could be increased to about 25 million, then the net effect would be equivalent to a reduction of about 17,000 private automobiles seeking parking places during the day.

Construction Operations - If the tracks are to be removed it will be possible to do some of the work in the track area while trains are still running. Portions of the railway could be operated on single track, assuming the present rail service continues during the construction period. However, if both rails are to be removed there will be several months during which the space occupied by rails could not be used, the space being required by the contractor for his operations. In addition, some of his operations will encroach at certain times of the day on the lower deck vehicular roadway.

Public vs: Private Ownership and Operation of the Transbay Rail Facility

In a study of the future of the Bridge Railway it is impossible to avoid reference to the question of whether the transbay railway facilities or any mass transit facility should be owned and operated by the public or should continue to be operated by a private company under regulation by the PUC. The present trend, judging by what has been done elsewhere, is toward public ownership and operation.

The advantages of public operation result primarily from the elimination of taxes and the primary objective can be service to the public even at some cost to be paid for out of other taxes. Private operation, on the other hand, is influenced by the desire of the stockholders to receive as much profit as possible.

The "Majority Report of the Mayor's Transit Ownership Committee" of St. Louis, released on October 15, 1952, states: "There is, there has been, and there will always be a large segment of the population which is dependent solely on mass transportation facilities as a means of transportation.....The obligation of the municipality to provide adequate mass transportation when deemed necessary has long been recognized in the United States and the concept is neither revolutionary or socialistic.....The committee is unanimously of the opinion that if private industry is unable to furnish an adequate mass transportation system under conditions which exist and which are likely to continue to exist for a substantial period of time, the municipality not only has the right but is under the duty and obligation to provide such transportation. In the opinion of the committee we are not here concerned with the question of an encroachment by government into a field that has previously been regarded as falling within the exclusive domain of private industry. There is no ideological question involved."

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"It is clear . . . in the case of a privately owned company subject to Federal and State income taxes that, under the existing tax structure, more than 50% of the additional revenue obtained from a fare increase neither improves the Company's financial provision or its ability to provide better service . . . This same increase in revenue granted to a publicly owned company would be available either to provide better service and better equipment or to fortify the financial position of a publicly owned authority.

"A publicly owned authority would not be required to pay Federal Taxes on gasoline, which constitutes a substantial item."

- - - - - - -

"A privately owned system is rightfully entitled to make a reasonable profit." In response to an inquiry presented by the Committee to the private Company, the latter stated that "the Board of Directors (of the Company) felt that it was obligated to operate and manage the properties in such a way as to produce for the Company and its stockholders the reasonable profit to which the Company was entitled under the law, and that if increased fares and curtailed service, in light of higher costs of operation, were necessary to produce such a result, the only course that the Board of Directors could pursue in the discharge of its obligation to its stockholders was to seek such increased fares and to curtail service.

"It was freely conceded by representatives of the (Company) in the hearings before the Committee that each fare increase and curtailment of service results in the loss of additional riders.

"A publicly owned authority would be regarded as having fulfilled the function if it provided adequate transportation at a reasonable rate and was able to do so on a self-sustaining basis without making any profit."

- - - - - - -

The 1951-52 Key System Annual Report and financial statistics quoted in the financial press, indicate the tax burden borne by the Company in each of the years indicated as follows:

Year	Gross Revenues, Local and Transbay Lines, and Miscellaneous	Income and Other Taxes as Percent of Gross Revenues
1948	$15,052,042	
1949	14,117,551	7.9%
1950	13,165,774	8.3%
1951	13,520,423	10.8%
1952	13,498,860	8.0%
1953	10,316,784	8.0% (Est.)

Note: Federal transportation tax did not apply during period covered in above table, except for last part of 1953.

It is not possible to prepare a breakdown showing the taxes on the transbay operation as compared with the local lines. It is expected that half of the transbay patrons will buy commute books and thus avoid the Federal Transportation tax. On this basis, the total tax paid directly or indirectly by transbay patrons is estimated to be about 15% to 17% of the total fare. Under public operation, these taxes would be practically eliminated.

SUMMARY OF FINDINGS

As a result of the studies contained in this report the following conclusions seem evident:

First: Continued decline of mass transit patronage across the Bay Bridge, both rail and bus, with a severe drop following the 1953 Key System Strike, indicates that mass transit across the Bay is becoming a minor traffic facility and Key System has stated its intention to ask permission to substitute bus service for all trains within a year or two.

The Bridge Railway occupies space equivalent to two vehicular lanes, but the passengers now carried during the peak hour, (in one direction) could be handled by less than 100 buses, which would absorb only a fraction of the capacity of one vehicular lane.

Second: Retention of the Bridge Railway without taking steps to improve the situation by some means that will divert transbay passengers from autos is not desirable. The need for additional roadway capacity on the bridge is so pressing that the retention of the Railway for the small number of persons now using it is an economic waste.

Third: It is physically practicable to operate the present Bridge Railway as a shuttle on a stop-gap basis between the San Francisco terminal and a terminal at 40th and San Pablo in Emeryville as suggested by Coverdale & Colpitts. But this would neither attract mass transit patronage nor relieve bridge congestion; more likely it would cause additional diversion of mass transit patrons to private automobiles.

Fourth: To arrest the present decline and regain at least some lost patronage requires costly improvements to convert the present semi-streetcar facility into a rapid transit system operating at relatively high speeds and with infrequent stops. This contemplates construction of high-speed feeder lines to points in the East Bay con-

veniently reached by bus lines and private autos, with parking space for the latter. It also contemplates the purchase of modern, high-speed rolling stock.

Fifth: A suitable rail service can carry a greater number of people over the bridge than can be carried by any other practicable means. It will do this at the least over-all cost and will compete in travel time with the private automobile. It entails large expenditures for extending the main trunk lines on separated or improved rights-of-way and for the purchase of high-speed equipment. The minimum expenditure for this part of a coordinated mass transit system would not be less than $20 million.

Sixth: The space now occupied by the rails can be refloored with either a removable steel-grid or plate deck or with a permanent concrete deck. A removable floor which has been suggested as a "temporary" expedient will cost about the same as a permanent floor and take almost as long to construct. It has been proposed only as a stop-gap until the Bay Area Rapid Transit Commission can arrive at a decision as to the future use of the railway. It would thus be possible to preserve the Bridge Railway facilities in case the tracks are later required for transbay rapid transit but it is economically unsound and in addition it has certain hazards, particularly increased danger from fires.

If the tracks are replaced, permanently or temporarily, and mass transit is handled by bus, it is only a matter of a short time before added delay due to increasing auto and truck traffic on the lower deck can cause a breakdown of the bus transportation service. Entire decking over the rail facility would immediately benefit private automobile traffic, but it would seriously limit the maximum number of people that could be carried across the Bay. An immediate benefit would also be the higher return from bus passengers (2.5¢) over that now received from train passengers (1.75¢). More space on the bridge for vehicles does nothing to alleviate congestion within the metropolitan centers on either side of the Bay and adds to the parking problem.

Reflooring the railway section will require time to complete the necessary work of financing, preparing plans and getting contract work under way. The time required for a Contractor to complete the project is estimated to be 15 to 20 months, during the latter 6 or 8 months of which the rail facility would be out of service.

Seventh: The Bridge Railway, if extended and converted to serve as a high-speed unit of a Bay Area rapid transit operation, might possibly handle the expected future mass-transit load even if one track is removed on certain parts of the bridge to permit building a fourth vehicular roadway lane.

The practicability of such a plan has been generally explored and while its advantage is obvious it introduces difficulties in train operation, has a certain degree of inflexibility, and would have to operate on somewhat less desirable schedules than a double track line. Furthermore, a new tunnel would be needed to carry a full four-lane roadway across the Island. This seems to be the only possible means of securing additional vehicular capacity and still maintain to a large degree the rapid transit potentialities of the Bridge Railway.

Eighth: Regardless of whether rail or bus operation is decided upon a large expenditure from $12 million to $30 million, depending on the plan adopted, will be required. Furthermore, any of these plans will require considerable time to complete. Also, there are no funds presently available for undertaking more than very minor work associated with these improvements and there is no public agency now organized and equipped to construct and operate such a rapid transit system.

Since it appears certain that there would be opposition to further subsidizing a privately-owned system, the formation of a public transit authority with necessary legal powers seems the only alternative.

PART II
HISTORY

HISTORY OF BRIDGE RAILWAY

The earliest proposals for a bridge connecting San Francisco with the East Bay contemplated the inclusion of interurban rail facilities. In the Hoover-Young Report of August 1930, the problem of providing rail transit facilities was given considerable attention. The report recommended that any bridge should have not less than three electric railway tracks and the width of lower deck of the recommended bridge indicated space for four tracks. It was also recommended that the San Francisco terminal consist of a loop, including an elevated line on Minna Street extending from First to Sixth Street. The construction of this railway was also recommended by a Citizens' Financial Advisory Committee.

It was recognized that commuters living in the East Bay, then numbering about 50,000, were an essential factor in the Bay crossing problem. It was stated in later reports that the bridge was designed as much for this great mass of commuting traffic--ranging from 35 to 40 million train passengers yearly before the depression--as for automobile traffic.

During 1930 and 1931 further progress was made on the design and it was decided to reduce the number of railway

tracks from three to two.

The plan for the Bridge Railway as of 1933 contemplated a two track shuttle system operating between a San Francisco terminal and an East Bay Transfer Station. The proposed location for the shuttle terminal in 1933 in San Francisco was within the block bounded by Mission, Howard, Fourth, and Fifth Streets. The location for the East Bay Transfer Station as then proposed was in the general vicinity of the Yerba Buena Yard--south of Yerba Buena Avenue, north of MacArthur Boulevard, east of the Southern Pacific tracks, and west of Peralta. Both Key System and Interurban Electric Company (Southern Pacific subsidiary) trains were to operate to the East Bay transfer station, where passengers would board fast shuttle trains for the trip across the Bay.

The above plan was modified to provide a direct through trip for both Key System and Interurban Electric patrons. Additional sites for the San Francisco terminal were studied in detail, and the recommended plan for a terminal between First and Fremont Streets, just south of Mission, was adopted in 1934.

After prolonged negotiations with the carriers, and numerous conferences with the cities, the State Railroad Commission, and the Reconstruction Finance Corporation, a plan was finally evolved and a loan was obtained to undertake the actual construction of the Bridge Railway and the San Francisco terminal.

Bridge Railway service was commenced on January 15, 1939. Initially, there were three carriers: Key System, Interurban Electric, and Sacramento Northern.

Unfortunately, patronage fell far short of expectations, and Interurban Electric was forced to abandon its operations in 1941, only two years after service had been inaugurated. With each progressive abandonment of an Interurban Electric line, service was taken over by Key System, either with rail equipment or buses. By July 26, 1941, all Interurban Electric lines had been abandoned or taken over by Key System. Also, on July 13, 1941, service on the Sacramento Northern was discontinued.

In August 1941, transbay rail lines operated by Key System were as follows:

A Line via 12th Street to East Oakland
B Line via Grand Avenue
C Line to Piedmont
E Line via Claremont Avenue to Claremont Hotel
F Line via Shattuck Avenue and Tunnel to Thousand Oaks

With the exception of service on the A Line to the east of Lake Merritt which was discontinued in 1950, all of the above lines are operating substantially in accordance with the plan adopted in 1941.

That portion of the F line trackage north of Dwight Way is owned by the City of Berkeley, and Key System operates over this line under the terms of an agreement with the City. In the event Key abandons service on the F line, it is not known what disposition would be made of the city-owned rails.

A portion of the C line is operated in cooperation with the Sacramento Northern Railway, this trackage forming a portion of the Sacramento Northern main freight line operating through a tunnel to the Moraga Valley. However, Sacramento Northern is now in the

process of abandoning its connection to this line.

In 1941 Key System also operated six so-called basic fare bus lines and five so-called deluxe or extra fare bus lines, all to areas not served by the rail lines.

Recent Developments

On December 3, 1952, Key System filed a petition before the Public Utilities Commission requesting permission to abandon rail service on the A Line (12th Street, Oakland) and the B Line (Grand Avenue, Oakland) and to substitute bus service.

Because of the proprietary interest of the Toll Bridge Authority in the Bridge Railway and because of the increasing vehicular congestion on both the upper and lower decks, the Authority was vitally concerned with the proposal of Key to abandon the A and B lines. In order that the Authority might be properly advised, the firm of Coverdale and Colpitts, Consulting Engineers, was retained to study the Bridge Railway and related traffic matters and to make recommendations as to use of the rails. In its report to the Authority dated May 15, 1953, Coverdale and Colpitts recommended that the rails be retained on the bridge, at least until such time as a final determination is made with regard to the future of rail rapid transit in the Bay area.

On the basis of this report, the Toll Bridge Authority on July 1, 1953, voted to oppose the application

of Key System, and to appear through counsel in the proceedings before the PUC.

The hearing on the proposed abandonment of the A and B Lines was held by the PUC on July 16-17, 1953. Key System presented evidence showing that operation with buses was more economical than with rail cars. The City of Oakland did not protest abandonment of the A Line, since it contemplates making 12th Street a one-way street, which is not possible as long as the A Line is retained. However, Oakland did protest abandonment of the B Line.

The City of San Francisco protested the abandonment of both lines, primarily because of congestion caused by bus loading from the streets in San Francisco.

The Toll Bridge Authority opposed the abandonment of both lines because of the added vehicular congestion which would result on the lower deck of the bridge.

A strike of Key System employees began on July 24, 1953, and extended through October 7, 1953. During this time there was no interurban mass transit service across the Bay---either train or bus---except for the Southern Pacific Ferry. Patrons of the Key bus and rail lines were forced to find other means of transportation, which meant the additional use of private automobiles. As a consequence, the number of vehicles on the bridge reached approximately 105,000 vehicles per day on several occasions, with some 109,035 on Friday, September 18, 1953. Extreme congestion

was avoided to a large extent through the assignment by the Cities of San Francisco and Oakland of additional traffic officers to assist in controlling traffic on the approaches. The trucking industry cooperated to a considerable extent by refraining from using the bridge during the peak hours, and the Southern Pacific Ferry carried many passengers during the peak hours. There was also some voluntary "spreading of the peak" on the part of individual motorists.

With no bus traffic the three lane lower deck was successfully operated with two lanes in one direction and one lane in the opposite direction during the peak hours. A substantial number of private autos were thus diverted from the upper deck to the lower deck.

Application for Abandonment Denied

The Public Utilities Commission rendered its Decision No. 49307, Application No. 33920, dated November 10, 1953, denying Key System's petition to permit substitution of buses for trains on the "A" and "B" Lines. The decision recited the general opposition of the East Bay cities, commuter groups, and the City of San Francisco to this move.

However, the PUC observed that bus operations "would be cheaper, more frequent, and generally faster than rail service," but stated the Company had failed to present "a sufficiently comprehensive plan for conversion of rail operations to motor coach service" on these lines. It seems obvious that if Key System were to submit a petition request-

ing abandonment of all of the rail lines together with a satisfactory scheme for loading buses at the San Francisco terminal, the Commission would be sympathetic to the Company's plea.

The decision allowed certain fare increases, of which most pertinent to the Bridge Railway was an increase in the basic transbay cash fare from $0.35 to $0.50 one way, and an increase in the price of the 20-ride commute ticket from $6.50 to $8.00.

The Commission stated that "in light of the several fare increases granted to this applicant in the recent past and the results following from such increases, it is not beyond the realm of possibility that the operations of this carrier are closely approaching the economic level governed by the law of diminishing returns.

"Only experience can demonstrate when such level is reached. There is no legal presumption that an increase in rates will decrease revenue. In order that we may know as soon as possible that this carrier's operations are running afoul of the law of diminishing returns, we will direct our staff to make periodic checks of applicant's operating results and to report their findings to the Commission."

The following pertinent remarks are also found in the Decision of the PUC.

"Studies presented by the Commission's staff indicate that though running times and frequency of service would be improved by conversion of the "A" and "B" rail lines to motor coaches and that the lower deck of the bridge could handle the additional buses required for the substituted service, the lack of additional bus loading space at the San Francisco Terminal would increase peak hour congestion in that area.

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"Cost studies presented by the staff indicate that complete track rehabilitation, with girder rail, on the "A" and "B" Lines will cost $1,302,580, while temporary track improvement program for at least five years' operation will cost $465,105, the work to be spread over five years in each case. For a period of less than five years, the studies show, the company could probably continue to maintain the "A" and "B" trackage in the present rough standard, with either increased maintenance expense, carrying out portions of a track repair program, or by operating trains under slow orders.

"The record leaves no doubt that the company has been facing a condition of declining transbay traffic for several years, both by rail and by motor coach, and that bus operations would be cheaper, more frequent and generally faster than existing rail service on the "A" and "B" Lines. The decline in bus and rail traffic, studies indicate, is due to several causes, important among which is increased use of private automobiles aided by comparatively low bridge tolls.

"The record, however, makes it abundantly clear that the company has not presented, at this time, a sufficiently comprehensive plan for conversion of rail operations to motor coach service on its "A" and "B" Lines. Notably absent from the company's showing is any provision for adequate use of the existing San Francisco Terminal for bus operations, either for the "A" and "B" Lines alone or for all bus operations in the event of abandonment of the other three rail lines. Morever, the objections raised by the City of San Francisco and others, concerning peak period congestion in the San Francisco Terminal area, find strong support in the evidence.

"The foregoing considerations, together with a careful study of the record, lead us to the conclusion that applicant has not made a sufficient showing in justification of its proposal to substitute motor coach service for its existing "A" and "B" rail lines and that the public interest would be adversely affected by applicant's present proposals if carried out."

Reasons for Key's Desire to Abandon the Rails

It is of interest to inquire into the reasons why Key System believes it financially desirable to discontinue its remaining rail operations. The statistics presented by the PUC engineering staff in Exhibit No. 5, page 8, Application No. 33920, show the comparative direct costs of operation with rail equipment as compared with bus service:

Estimated Direct Charges for Operation of "A" and "B" Lines*

Item	Rail	Motor Coach
Electrical Power vs: fuel, fuel taxes, & oil	$107,900	$ 64,100
Trainmen or Operators wages	192,000	164,500
Track and roadway maintenance	62,400	-----
Electrical overhead maintenance	25,900	-----
Maintenance of revenue equipment	113,200	24,500
Carhouse employees	60,100	-----

*(Entire list is not reproduced here)

Summarizing these financial studies, it appears the substitution of bus service would save between $58,000 and $253,200 in annual operating costs, depending on assumptions made regarding amortization, etc.

The proposed motorizing of the "A" and "B" Lines would have involved 3475 bus miles of operation on the two lines for a typical week day as compared with about 2423 unit miles on the rail lines. Actual operating expenses for the motor coach lines were estimated at $398,400 as compared

with operating expenses on the two rail lines of $706,400. However, for the motor coach operation it would be necessary to add interest on the new equipment; costs involved for track removal and repaving; interest on unamortized, undepreciated balances of investment in track, roadway, and equipment; and amortization of undepreciated balances of investment in track, roadway and equipment.

The various costs of maintenance and operation for the first six months in 1953, assuming no track rehabilitation, indicate an incremental cost per unit mile of rail operation of 92¢ or more as compared with 32.5¢ per bus mile. Bus operation would be more economical than rail operation because of the present poor load factor on the trains and the necessity for operating so many partially empty trains. This results in heavy expenditures for maintenance, power, and operator's wages, all of which could be reduced if the smaller, lighter, one-man buses were substituted. In other words, on these two lines, the same transportation service could be provided with buses offering only about sixty million seat miles per year as compared with 100 million seat miles available on the trains. Thus Key System's financial troubles may be attributed in large part to the unfavorable load factor on the present rail lines. Key System, in common with the urban transit industry throughout the country, shows a high ratio of operating costs to gross revenues. Only a modest percentage change in either revenues or expenses is reflected in a sizable

shift in coverage of fixed charges. With patronage and revenues falling off, and with operating costs rising, Key System has been forced to take all feasible measures in an effort to prevent costs from exceeding revenues.

Figures collected by the Public Utilities Commission showing results of operations for the year ending 1953 indicate a total operating loss for the transbay rail and motor coach lines of $231,803, of which $203,677 was the result of the rail operation and $28,126 was the result of the motor coach operation. The local motor coach operation showed an operating profit of $339,082, before interest, depreciation and allowance for charges for abandoned street-car lines.

From the foregoing it is evident that insofar as Key System is concerned, transbay rail operation in 1953 was its "white elephant", the out-of-pocket cost of performing this rail service exceeding the operating revenue by more than 8 percent. The figures were, of course, affected by the strike and the 75-day suspension of service.

Information collected by the PUC showing the financial condition and results of operation for the first four months following the end of the strike indicates that Key System Transit Lines and its parent Company, Railway Equipment and Realty Company, Ltd.* on a combined basis are losing money. Figures collected by the PUC indicate a loss after fixed charges and depreciation of $55,238.

*The controlling interest of 64% of the common stock of Railway Equipment and Realty Company and its subsidiary, Key System, was purchased on May 15, 1946, by National City Lines at a cost of approximately $3,000,000. National City Lines is a holding company owning local transit systems in many cities throughout the country.

Although the statistics do not leave much doubt that buses would be more economical than trains insofar as Key System's balance sheet is concerned, this does not necessarily mean that the real cost of providing transportation service by bus would be less than by rail. For instance, the cost of conversion of the lower deck to accommodate buses would not be borne by Key System and therefore does not show in the financial comparison. Interest alone on the bonds required to finance this conversion would probably be enough to offset the saving in operating costs that might be achieved with buses.

As noted elsewhere in this report, the Bridge Railway has a depreciated value in excess of $12,000,000 and a replacement value on the order of $25,000,000. The total investment of Key System in property and equipment as carried on its books on December 31, 1953, was $7,910,552. This means the investment of Key System in buses and other equipment required to furnish the East Bay local motor coach service, the transbay motor coach service, and the transbay rail service is but a fraction of the present investment of the California Toll Bridge Authority in transbay railway facilities which Key System proposes to abandon.

General Situation Confronting Public Transportation Companies

The plight in which Key System finds itself is more or less typical of the entire mass transit industry. In its report covering the fiscal year ending June 30, 1953, the Public Utilities Commission noted that "privately owned passenger

transportation companies....in many instances, are fighting for survival." The Commission stated that during this 12 month period mass transit patronage in California dropped 112,000,000 passengers as compared with the preceding year. Loss of travel on all electric rail route lines regulated by the Public Utilities Commission in California fell off 12%--from 133,000,000 to 117,000,000.

The report stated that "as fares went up and fewer riders patronized public transit and electric, trackless trolley and bus lines, revenues further slumped and unit costs increased. In numerous instances bus and electric lines operating at a loss were discontinued where service was greatly reduced.

"As costs and fares went up, patronage decreased, resulting in additional applications for higher fares and for permission to reduce service.

"The transportation industry has not yet found an answer to this vicious cycle".

The PUC noted that car pools and individuals riding in private cars have cut deeply into metropolitan transit patronage, and has created a situation over which the PUC has no control.

These developments have occurred simultaneously with the tremendous increase in population. Thus, the statistics showing decline in patronage do not give the complete picture, since per capita usage of mass transit has fallen off still more.

There are no indications of a change in this overall transit situation since registration of private automobiles continues to increase. On the other hand, the transit companies are likely to be subjected to increased costs of labor, taxes, and equipment charges and, on the basis of previous experience, change in economic conditions in the nature of a recession or depression would probably be reflected in even less mass transit riding.

In many large cities the difficulties faced by private enterprise in attempting to serve the mass transit needs of the community have resulted in public ownership. Practically all transit operations in New York, Chicago, Cleveland, Seattle, Boston and San Francisco, to mention but a few, are now publicly owned and operated. In Philadelphia the subway and rapid transit system is owned by public agencies, but is operated by a private company.

Privately operated mass transit has an extremely unfavorable operating ratio compared to other private utilities, over 75% of income being required to defray the actual cost of service. Various experiments to improve the situation have met with little success. For instance, in St. Louis a program designed to attract more transit riding paid the cost of the additional gasoline required for the additional buses only, but failed to cover labor costs, maintenance and equipment, etc. Among the nation's major industries--chemicals, oils, auto builders, railroads, etc., totalling 70 in number--public

transit generally ranks at or near the bottom insofar as earnings are concerned.

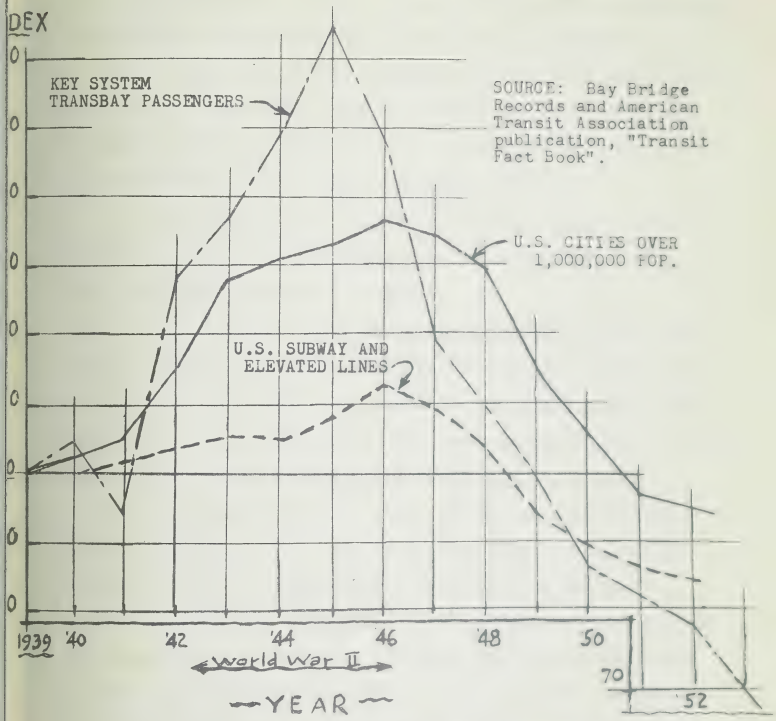
Statistics compiled by the American Transit Association permit a comparison of the transbay rail and bus situation with mass transit patronage in other large cities and to all transit riding in the nation at large. Assigning an index of 100 to transit riding for the base year 1939, Fig. I-1 shows the relative performance of Bay Bridge transit.

Disregarding the high war-time peak, largely due to sailors riding to and from Treasure Island, it is observed that transbay patronage has fallen off more rapidly than general patronage of mass transit in cities of comparable size.

The decline has been more pronounced on surface routes - streetcar and motor bus - than on subway and elevated lines. This indicates that in metropolitan areas the surface (feeder) lines are relatively more vulnerable to competition from the private automobile. The advisability of converting the East Bay lines from surface operation to rapid transit operation at separated grades is thus indicated.

Description of Bridge Railway

The railway on the bridge was built in 1937 and 1938. The first train using the Railway arrived in San Francisco 5:53 AM, January 15, 1939. It consists of a double track system extending from the terminal in San Francisco a distance of 6.1 miles to a connection with Key tracks on the mole. A third or contact rail is used for delivery of electrical power. Length of track under



RELATION OF KEY SYSTEM TRANSBAY TRANSIT PATRONAGE TO TRANSIT PATRONAGE IN OTHER LARGE CITIES AND TO NATIONWIDE PATRONAGE ON SUBWAY AND ELEVATED LINES

Toll Bridge Authority ownership totals 23.31 single track miles, of which 15.88 miles are main tracks, 6.27 miles setout and other yard tracks, and 1.16 miles are crossovers and switches.

Weight restrictions required an open deck track construction on the bridge. The Yerba Buena Island crossing and the San Francisco loop, including all track on the viaduct and in the terminal, are of ballasted construction.

The ties for the railway are redwood spaced on 12" centers, and supported on longitudinal steel stringers which frame into the lower deck floorbeams.

Track rails are 90-pound A.R.A. Section. The entire length of track on the bridge is protected by guard rail, which is also 90-pound Section. In addition, two 5"x8" timber guard rails per track are installed. The track is secured to the steel work by hook bolts in every third tie.

In this track work, there are two departures from standard construction. First, the large movements at the expansion joints are considerably greater than on any other structure. Hence, a new design of rail expansion joint was required which has proved to be satisfactory although the cause of considerable maintenance work. Some 22 of these expansion devices are required for the bridge crossing. Second, a new design of flange-way guard rail was developed to insure against derailment on the 20 degree curves in the San Francisco loop.

The contact rail system is almost entirely 150-lb section, although 55 pound rail is used in the terminal and on short runs adjacent to cross-overs.

Ruling grades on the bridge are generally 3%. The east approach to the East Bay cantilever span involves a mile-long grade of 2.74%. There is one short section of track in the terminal on a 4% grade. The grades are not compensated for curvature.

On the San Francisco loop where the 20 degree curves prevail, speeds are currently limited to 17 mph.

Almost all of the overhead catenary used in connection with the former Interurban Electric operation has now been removed. On the bridge Key System cars operate from the third rail at 625 v. DC, but on the East Bay surface lines delivery of electrical power is from overhead catenary.

Under the terms of the contract between the Toll Bridge Authority and Key System, the latter maintains all railway facilities at its own expense. Periodic inspections have been made on behalf of the Department of Public Works by experienced consulting engineers specializing in railway work. The most recent such inspection was made early in 1953 by Mr. Walker Paul. Mr. Paul found that the Bridge Railway is beginning to show signs of progressive deterioration, that the general level of maintenance is not as high as might be desired or would be required for a rapid transit operation, and that there is some deferred maintenance. The cost of restoring the Bridge Railway to first-class condition has been estimated at $75,000 in addition to regular maintenance.

In general, the most serious condition on the Bridge

Railway insofar as deferred maintenance is concerned involves the ties, which show signs of advanced wear beneath the tie plates. This is a difficult condition to prevent, but can be corrected by installing shims beneath the tie plates. Almost all of the ties are now 16 or 17 years old, and no doubt replacement of many of them will be necessary during the next ten years.

The details of Mr. Paul's report are too extensive to be reprinted here, but the report is on file in the Department of Public Works.

Bridge Railway Rolling Stock

The Bridge Railway rolling stock consists of 87 articulated units, each 110 feet long and each providing seats for 132 persons. Of these units, 51 are owned by Key System and were rebuilt from older equipment in 1937. The remaining 36 units are owned by the Toll Bridge Authority. There were originally 37 State-owned units, but one of these has been damaged beyond economical repair. Of the State-owned units, 23 were built new by Bethlehem in 1936, and the remainder were rebuilt from the older equipment.

In practice the articulated units are made up into trains of one to three units each. A one-unit train requires one operator and one conductor. Each additional unit added requires one additional conductor.

One of the principal complaints on the Bridge Railway Service as it is now operated is slow operating speed. The

speed is limited by the power (440 HP) and braking capacity of the present rolling stock.

The present 132 seat units are too large for most of the off-peak demand on the several lines as now operated. For instance, in 1952 the majority of scheduled trains on the "C" and "E" Lines carried less than 50 passengers. Only during the peak hours was there a greater demand than could be accommodated by a single bus or one-man street-car with 48 to 60 seats. Similar conditions prevail on the "B" Line.

Due to the decline in traffic the maximum number of articulated units used in recent years has been 57 and only 51 at the beginning of 1954. Key System petitioned the PUC on September 27, 1951, to sell 25 units and permission was granted to dispose of 21 of them. Apparently Key System has been unsuccessful in locating a purchaser.

Depreciated Value of Bridge Railway Rolling Stock

Because of their age and limited speed the existing articulated cars may be considered semi-obsolete, and their eventual modernization or replacement must be given consideration if the Bridge Railway is to be retained. It is pertinent, therefore, to discuss the present value of this rolling stock.

The two-car units owned by Key System and by the State originally cost from $57,000 to $68,000 each. The question of the depreciated value of these units, now over 17 years old, was discussed by Mr. Walker Paul, Consulting Engineer, in his report

to the Dept. of Public Works dated May 22, 1953. For purposes of depreciation Mr. Paul was of the opinion that the value of one of the units as of September 1951 was $29,315.

Using the same line of reasoning as followed by Mr. Paul, it would appear each of the units as of January 1, 1954, would be about 63½% depreciated. On this basis, the total value of all of the State-owned units (now carried on the books at the original cost of $2,470,000) would be approximately as follows, as of January 1, 1954:

Number of Units	Type	Original Cost	Present Unit Value	Total Value
14	Rebuilt	$57,282.82	$20,908	$282,712
22	New	67,699.61	24,710	543,620
1	Originally new, now destroyed.	65,000.00 (to TBA)	29,315*	29,315
			Total	$865,647

*Subject to adjustment with Key System. Figure shown based on Mr. Paul's report.

Financial Status of Bridge Railway Investment

The original cost of the Bridge Railway, less subsequent writeoffs, depreciation, elimination of items which would continue of benefit to the people of the Bay Area, was as follows:

Original total cost	$18,318,305.81
Deduct write-off of unneeded and unusable facilities following abandonment of Interurban Electric and Sacramento Northern	3,399,003.31
Net remaining book value	$14,919,302.50

The above book value does not include any allowance for depreciation of the existing units owned by the Toll Bridge

Authority. Neither does it make any allowance for obsolescense or depreciation of fixed facilities, such as track, signals, ties, etc. Therefore, the following deductions should be made from the above book value to arrive at some indication of the net remaining investment in the Railway facilities:

Depreciation of Bridge Railway investment in rolling stock leased to Key System, now semi-obsolete ($2,470,000 - 865,647)	$1,600,000 approx.
Estimated depreciation of ties, rails, signals, etc.	500,000 approx.
Total	$2,100,000
Net remaining investment in railway facilities	$12,819,000 approx.

If the bridge rails were removed, the San Francisco Terminal and approach viaduct could be made useable for buses. Even if the rails were used again at some later date, there will likely be some bus service across the bridge into San Francisco, and the present railway terminal could serve permanently as a bus terminal, although the location is not ideal. Thus, the investment in the terminal facilities, rights-of-way, and the approach viaduct should not be considered lost if buses are substituted for rail service, and this cost might also be included as a deduction from the above "remaining investment".

The original cost of the San Francisco viaduct, terminal building, etc., included in the above railway investment, was as follows:

	(Brought Forward)	$12,819,000
San Francisco Viaduct	Less:	- 615,000
Rights of Way		- 3,444,000
Terminal Building		- 2,614,000
Engineering, Insurance, Architecture, Administration, Legal, etc. (pro-rata)		- 1,000,000 (approx.)
Required write-off of Bridge Railway facilities if Bridge Rails removed		$5,146,000

In other words, if the tracks were removed a net remaining investment of some $5 million would be lost. At current construction prices, this represents a present value of about $12 million. (Salvage value is assumed to be negligible.)

Thus, if the tracks are removed it would be necessary to destroy a facility that has a book value of approximately $12 million. However, the present actual value of this facility is very little since it serves a very small fraction of the total transbay passenger load. The above value could only be realized if a system of rail rapid transit were financed and placed into operation. However, retention of the Bridge Railway tracks on the Bridge under present conditions is sacrificing potential vehicular capacity and this constitutes an intangible loss to the public which must also be considered.

Obviously, in case Key System is ever allowed to discontinue its rail services, consideration must be given to utilizing the space now occupied by the rails for vehicular traffic. The idea is by no means new, and has been suggested or advocated on numerous occasions in the past. The most comprehensive study of what would be involved if bus service is substituted for rail service was made by the State Division of Bay Toll Crossings, whose

findings are contained in a report dated October 1949. (This is discussed in more detail in a subsequent section.)

Main Line Trains

From time to time in the past the possibility of operating main line trains over the Bay Bridge has been investigated by the carriers and by others, but it has generally been concluded that such operation would be uneconomical and infeasible. It would require 1) development of new motive power of lighter weight than the present diesel locomotives, and 2) a new or expanded terminal facility, since the present terminal is inadequate both in length and in number of tracks. Moreover, any such usage of the Bridge Railway tracks for slow-moving main line trains carrying a small number of passengers would impair its usefulness in handling the large number of mass transit passengers involved in interurban service.

Relation of Present Transit Patronage to Original Railway Design Capacity

Before the Bay Bridge was built there was a widespread network of surface electric lines serving the various East Bay ferry terminals. In those days only a relatively few people drove their own cars to the ferry. Thus, the original concept of the Bridge Railway was that it would be an extension of these rail transit lines in the East Bay. Accordingly, the Railway was designed to permit 17,000 persons to be carried in one direction in a 20 minute peak period, or 50,000 per hour. This theoretical capacity was based on 10-car trains operating on a 63 second headway.

With the opening of the bridge roadways in 1936 conditions began to change. For one thing, it became possible for the East Bay commuter to drive at moderate cost and with a considerable saving of time directly to his place of employment in San Francisco. This increase of vehicular traffic tending to impair the movement of trains on city streets, hindered the mass transit operations. More and more automobiles are being used, new freeways are constantly being built reducing travel times, and more freeways are planned which may have more significant effect than those completed since World War II.

On the other hand, nothing has been done to improve the Bridge Railway facilities. The tracks (particularly the surface tracks in the East Bay) have been allowed to deteriorate and although electric rail transit equipment has been

greatly improved, the present 18-year old cars (some containing parts almost 50 years old) are still in service. These cars are limited to speeds of 20 to 25 mph on upgrades whereas modern cars could climb the grades on the bridge with speeds up to 60 mph.

When the Bridge Railway was designed it was not possible to foresee that rail surface operations in the East Bay, as elsewhere, were doomed by a new form of public transportation then in its infancy - motor coach lines. Consequently, the estimated peak load of 17,000 persons per 20 minute period was never attained. In 1946, the first year following the wartime peak, the maximum number of persons leaving the Bridge Terminal (both bus and trains) totaled less than 8,000 persons in a thirty minute period--only one third of the design capacity of the rail facility alone. By 1952 patronage had dropped to about 5,400 outbound passengers in the peak hour from the San Francisco terminal which is only 10 or 11 percent of its capacity.

Overall Trend of Loss of Mass Transit Patronage

As a result of these and other factors, there has been a steady decline of Key System transbay patronage, both rail and bus, since the end of World War II. Commuter traffic (not including Yerba Buena and other toll-free) dropped from 35 million in 1945 to 15-1/2 million for the year ending June 30, 1953--the last full year of operation

prior to the July-October, 1953, transit strike. For the latter half of the above fiscal year, the annual rate of traffic and the distribution between rail lines and transbay bus lines was approximately as follows:

Key System bus, transbay, toll-paying	6.20 million	trips per yr
Key System train, toll paying	8.83 million	do
Subtotal	15.03 million	
Key System, Yerba Buena and other toll-free	1.63 million	do
Total	16.66 million	do

The above toll-paying patronage represented a 9.9 percent drop as compared with the previous fiscal year.

In its report dated May 15, 1953, to the Toll Bridge Authority, Coverdale and Colpitts stated that in its opinion, "the Key transbay passenger trend will be substantially the same, whether Key continues its present train and bus routes or whether it substitutes buses for trains on any or all of the rail routes now operated". (pg 23) This opinion was based on the experience on the outer end of the "A" Line, on which a conversion from rail to bus ("K" Line) was made on October 29, 1950. However, due to circumstances not foreseen by Coverdale and Colpitts, this trend of decline in patronage has been accelerated. As one of the terms of settlement of the July-October strike, a wage increase totalling 18¢ per hour was won by Key System employees, and as a consequence a substantial fare increase was allowed by the Public Utilities Commis-

sion. Effective November 30, 1953, the basic transbay cash fare was increased from 35¢ to 50¢. This includes 1.75¢* bridge toll and approximately 6¢ Federal transportation tax. The previous fare was not subject to Federal tax. This is an increase of over 42%.

Cost of the transbay commute (20-ride) ticket for Zone 1 was increased from $6.50 to $8.00, or an increase of about 23%. No Federal tax is applicable to the commute ticket.

The strike ended early in October 1953, and it is reasonable to assume that the record during the month of November would afford an indication of the permanent effects of the strike on patronage, since during this month transbay and local fares were identical to those prevailing prior to the strike. Actual rail transit patronage during this month dropped 21% as compared with the corresponding month of 1952, and bus patronage was off 19%. Private automobiles on the bridge, on the other hand, increased during November 1953, as compared with the previous year.

The increased fares went into effect on November 30, 1953. As was expected effects on transit patronage proved to be severe as indicated by the following tabulation:

- -

*Figure is for trains. Toll for Key Buses is 2-1/2¢ per passenger.

Month and Year	Trains (Not Incl.YBI) Toll Free	Change from Corresponding Month, Prev. Year	Buses	Change from Corresponding Month, Prev. Yr.
November 1953	586,855	-21.5%	397,356	-19.0%
December 1953	590,735	-24.1%	406,810	-24.7%
January 1954	527,759	-29.6%	368,800	-29.8%
February 1954	518,492	-24.8%	355,916	-26.1%
March 1954	574,845	-26.2%	409,531	-24.7%
April 1954	547,041	-26.6%	392,741	-25.7%
May 1954	530,112	-27.8%	368,945	-27.7%

Note: See Appendix F for additional details.

The transportation tax was reduced from 15% to 10% on April 1, 1954, which reduced the transbay cash fare (for the central zone) from 50¢ to 48¢. Key System immediately petitioned the PUC for permission to restore the fare to 50¢ together with certain other increases in the cost of tokens and fares for school children. (Application No. 35309 dated April 2, 1954) The application was amended on July 9, 1954, requesting permission to abandon service on a large number of lines during the night hours and on Sundays and holidays. This information was presented to the Commission and interested parties at a preliminary hearing on June 30, 1954. At this hearing in answer to a question by the PUC staff Mr. Worthington stated that Key System expected to request permission to substitute bus service for its rail lines in one or two years. It was the opinion of Mr. Worthington that granting the

requests in the above application would not affect traffic over the Bay Bridge during the peak hours.

The formal hearing was held July 14 to 16 inclusive. To start the hearing Mr. J. R. Worthington of the Key System outlined the reasons why his company needed immediate relief and was forced to make drastic economies at once. Following the strike, the company lost money to and including March 1954 and were just "out of the red" in April. Their city lines have apparently recovered from the effects of the strike although there has been a continual drop in traffic at the same rate as has taken place during the past few years. Transbay traffic which had about the same drop during the strike has shown no material indication of recovery.

Detailed statistics covering Key System's operations as prepared by Key System and by the staff of the PUC will be found in the files of the Legal Department and the Bridge Department, Division of Highways. Extracts that seem particularly pertinent to this study have been contained in Appendix "F" for convenience of reference.

Present Means of Transbay Travel

The following tabulation indicates the mode of travel of persons crossing the Bay during the month of December 1953. Estimates of persons using private automobiles are based on 1.9 occupants per car. (See page I-40)

Mode of Travel	Estimated Average Number Passengers Per Day, One Way	
Key System trains (not incl. Gov't Toll Free)	19,000	(10%)
Key System, toll free to YB Island	4,000	(2%)
Key System Buses (not incl. drivers)	13,000	(7%)
Other buses, Greyhound, etc. (not incl. drivers)	10,000	(5%)
Subtotal, Mass Transit	46,000	(24%)
Automobiles, including toll-paying, Gov't toll-free, and vehicles between San Francisco and Yerba Buena and Treasure Islands	152,000	(76%)
Truck Drivers (not included)		
GRAND TOTAL (Persons)	198,000	(100%)
(Round Trips, Per day	95,000)	

Reasons for Loss of Patronage

Several causes for the recent slump of rail and bus patronage have been mentioned, the increase in fares, the strike, and adverse public reaction. Competition from the lower automobile tolls on the Bay Bridge and the failure to keep the Railway facility abreast of progressive technologic advances in the field of rail transit have also been mentioned.

To elaborate, travel conditions have progressively deteriorated, and no improvements have been made since the opening of the Bridge Railway to travel in 1939. Travel times have remained about the same as they were 15 years ago, and a trip on the Bridge Railway now requires half again as much time as a trip in a private car. Service

is less frequent, with 30 or 45 minute headways now prevailing on most of the lines. Age of the present equipment is reflected in low balancing speeds and high operating and maintenance costs. The tracks, both on the bridge and more particularly in the East Bay have been allowed to deteriorate in the last three or four years and become rough riding. As already stated, more and more freeways have been opened to traffic, thereby facilitating travel by private car, while nothing has been done to permit faster train travel. Motor coaches are proving more economical than rail surface cars which has prevented any further extension of the rail facility.

Some factors which seem to place the Bridge Railway at a competitive disadvantage with other forms of transportation are the following:

Location of San Francisco Terminal - The San Francisco Terminal being located on the fringe instead of the heart of the central business district requires many commuters to continue their trip by streetcar or on foot.

Poor Distribution Within San Francisco - A rapid transit system in San Francisco has not been built; only surface cars are available for those who desire to go to the outlying districts.

Streetcar Operation - In the East Bay tributary lines to the Bridge Railway operate largely on the

streets, some of which are busy ones. Because of such inadequate feeder lines and equipment it has never been possible to operate the transbay service as a genuine rapid transit line at relatively high speeds and low travel times.

Public Relations - In recent years Key System has been subjected to countless complaints from the public and the press with regard to almost all of its policies. Unfavorable publicity of this kind has tended to impair transit riding.

Five Day Week - In former years many banks, offices and industries were on a six-day week. Today there is a continuous shift to the five-day week, and this reduces the number of rides for those affected from 12 to 10 per week.

Decentralization of Downtown Areas - Many offices and businesses have moved away from the downtown areas to new locations in the outskirts not conveniently served by public transportation.

Suburban Living - Many new suburban developments are not, and in some cases cannot, be conveniently served directly by any means of mass transit.

Economical Commuting Distance - Much of the population increase in the East Bay has occurred in areas many miles distant from the bridge head. These areas may be regarded as being beyond the economical limit for transbay commuting via the existing public transit lines.

Self-sufficiency of East Bay Communities - In recent years the East Bay communities have tended to develop their own retail centers, cultural attractions, and business and industrial activities, thereby changing from their former "bedroom" status.

Television and Outdoor Movies - Television and attendance at outdoor movies has cut evening transit riding for recreational purposes.

Responsibility of Key System

Even if some policies and operating practices can be criticized, Key System cannot be blamed for the general decline in mass transit patronage. While the San Francisco Terminal and the tracks on the bridge embodied the latest advances in rail transit design, the rolling stock was semi-obsolete at the start. The need for maximum passenger capacity at the time made it necessary to utilize existing rolling stock, such as the circa 1911 Interurban Electric "red cars", which resulted in a sacrifice of speed. But more important was the failure to construct adequate high speed feeder lines in the East Bay. Laboring under such handicaps it is evident the Bridge Railway could not compete with the automobile and the motor coach.

It is apparent that Key System could not finance the essential lines on separated rights of way and new rolling stock which possibly would have retained

a large portion of the rail patrons. Experience in other metropolitan centers - New York, Chicago, Philadelphia, Boston, Toronto, etc. - has indicated that necessary subways or elevated lines must be financed in part at least from sources other than funds derived directly or indirectly from transit operation. Thus, the Key System operation was a victim of circumstances involving physical, financial, and political factors beyond its control. And no one foresaw the growth of rubber-tired vehicles.

Key System Rail Operation

The following mileages and time schedules of the rail lines prior to 1953 strike are illustrative of existing surface line operation.

Mile	Cross Street or Station	Eastbound Scheduled Time To Selected Points (Based on official time tables)
0.0	San Francisco Terminal	
6.32	Oakland Army Base	14 minutes
	"A" Line - 12th Street - Base service provided by four one-unit trains, 20 min. headways	
7.74	Peralta	
8.73	Poplar and 12th	21 minutes
9.75	12th and Broadway	27 "
10.21	Oak Street	31 "
	"B" Line - Grand Avenue - Base service provided by 3 one-unit trains, 30 min. headways	
8.14	Jct. with "A" Line at Poplar Jct.	
8.97	Grove Street	
9.30	Broadway	25 minutes
10.37	Grand Avenue-MacArthur	31 "
11.43	Grosvenor Place	
11.61	Underhills Station	39 "

"C" Line - Piedmont - Base service provided by 2 one-unit trains, 40 min. headways

8.02	Jct. with Berkeley Line at Adeline and Spring	
8.39	Grove Street	
9.05	Broadway	
9.23	41st and Piedmont	27 minutes
9.65	Piedmont Avenue and Pleasant Valley	
9.93	Grand & Rose Avenue (Piedmont Station)	
10.30	Oakland Avenue	33 "

"E" Line - Claremont Hotel - Base service provided by two one-unit trains, 45 min. headways

8.42	Jct. Berkeley Line at 54th Street	
8.77	Grove Street	
9.04	Shattuck Avenue	
9.19	Telegraph Avenue	
10.06	College and Claremont	
10.26	Alcatraz Avenue	
10.76	Ashby Avenue	
10.86	Domingo Avenue (Claremont Hotel)	33 minutes

"F" Line - Berkeley - Base service provided by 5 one-unit trains, 20 minute headways

7.45	Hollis Street	
7.76	San Pablo	19 minutes
8.65	Market Street	
9.17	Grove Street	
9.64	Ashby Avenue	
10.21	Dwight Way	
10.78	University Avenue	33 "
	Tunnel Under Arlington Circle	
12.39	Solano Avenue--The Alameda	41 "

Total base service was provided by 16 one-unit trains. In addition to these 16 units, some 35 additional units were used during peak-hours only, most of these making only one round trip per day. Of these units 12 are stored in San Francisco during the day, while about 23 units are picked up and dropped off by regularly scheduled trains at the Mole yard.

Thus a total of 51 units were in service, 36 units were idle at all times except for occasional use as spares, and one unit has been damaged beyond economical repair.

As noted from the foregoing, the majority of scheduled trains consist of only one articulated unit. The following shows the number of trains that carried two or more units:

Line	Eastbound Trains (PM Peak)	Westbound Trains (AM Peak)
A	2	1
B	4 or 5	3
C	4	4
E	3 or 4	5
F	8	7

An explanation of service on the "F" Line is of interest. As noted, base service is provided by five one-unit trains in constant operation. During the evening peak six units are added to the five trains, and three additional separate trains consisting of a total of eight units are added to the schedule, making a total of eight trains consisting of more than one unit. On this line it may be said the five units are in more or less constant operation, and fourteen units make only one or two round trips per day.

Under 1953 operating procedures a round trip cycle on the "F" Line required 90 to 95 minutes from the time of departure for the first round trip from Solano Avenue to San Francisco until the same train left again on the second round trip. Taking for instance Schedule 60: This train left Solano Avenue at 6:46 AM and arrived in San Francisco at 7:29, a total of 43 minutes running time. After waiting 3 minutes, it left San Francisco at 7:32

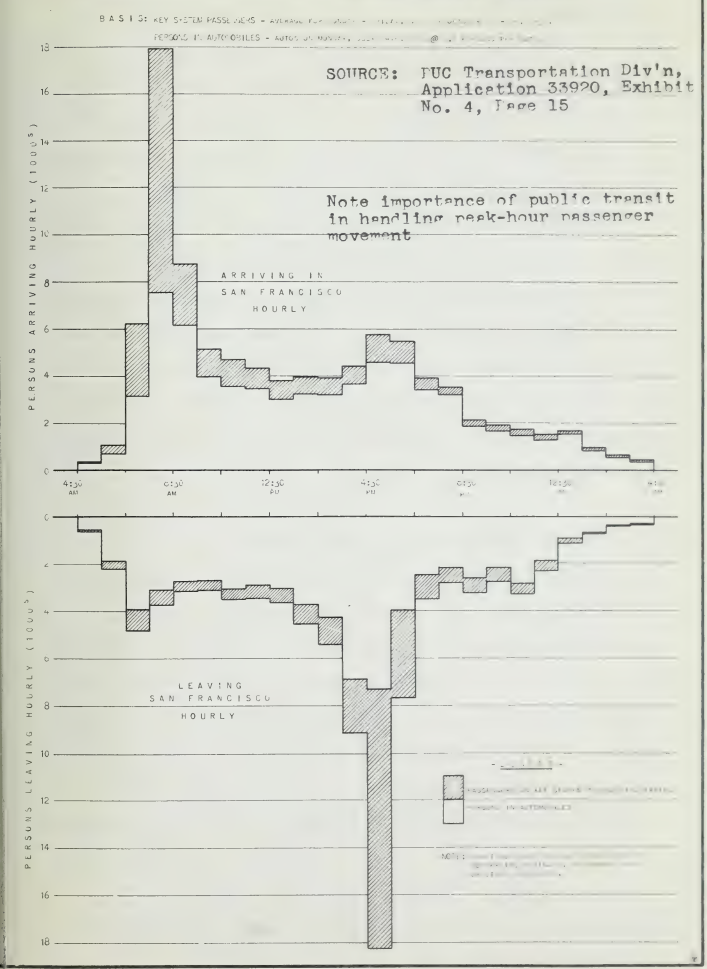
and arrived at Solano at 8:13 - a run of 41 minutes. The train left again at 8:21. Total time for the round trip cycle was 95 minutes. These figures are given to show the nature of existing rail operation involving the Bridge Railway. More complete and detailed information will be found in the exhibits prepared by Key System and the PUC staff in connection with hearings before the latter.

Nature of Transbay Commuter Movement

In contrast with the vehicular movement (which is in the ratio of about 1.3 eastbound to 1.0 westbound at the peak hour) the peak movement on the transbay Key rail and bus lines consists of workers from the East Bay to San Francisco in the morning and the exodus in the opposite direction in the evening. In the evening peak hour the directional movements are in the ratio of 9 eastbound to 1 westbound. In other words, there is very little commutation via bus or rail of persons living in San Francisco and working in the East Bay. This means many trains must return empty or nearly empty from San Francisco in the morning, and deadhead to San Francisco in the evening, although some of this deadheading has been reduced in recent months by storage of trains during the day in the San Francisco terminal.

Another difficult aspect of rail and bus traffic is its greater concentration during the peak hours compared to private vehicular movements. For instance, on three of

NUMBER OF PERSONS INTO AND OUT OF SAN FRANCISCO VIA SAN FRANCISCO-OAKLAND BAY BRIDGE ON A WEEKDAY


BASIS: KEY SYSTEM PASSENGERS - AVERAGE
PERSONS IN AUTOMOBILES - AUTOS OF HOURLY
SOURCE: PUC Transportation Div'n, Application 33920, Exhibit No. 4, Page 15
Note importance of public transit in handling peak-hour passenger movement
PERSONS ARRIVING HOURLY (1000's)
ARRIVING IN SAN FRANCISCO HOURLY
4:30 AM
8:30 AM
12:30 PM
4:30 PM
8:30 PM
12:30 AM
PERSONS LEAVING HOURLY (1000's)
LEAVING SAN FRANCISCO HOURLY

the rail lines--"B", "C", and "E"--more than 50% of the total eastbound passenger demand occurs between 4:30 and 6:00 P.M., and about 50% of the total westbound passenger demand occurs between the hours of 7:30 and 9:00 A.M.

The Key System rail and bus lines serve this kind of traffic movement; they act as feeder lines in the residential areas of the East Bay and deliver all of their passengers to a single point on the outskirts of the San Francisco central business district. East Bay residents can commute without transfer directly to downtown San Francisco, but San Francisco residents cannot make the trip to East Bay destinations without transferring from local San Francisco streetcars to Key buses or trains at the Bridge terminal building.

It is evident that it would be desirable to take steps to expand the commuter movement in the direction opposite to that of the peak. This would improve the load factor on the Railway and reduce the vehicular load in the direction opposite to that of the peak so that operation of the upper deck with four lanes eastbound and two lanes westbound might be practical. If traffic in the direction opposite to that of the peak is not diverted in part to mass transit, then such unbalanced operation is impossible.

Peak hour passengers going from San Francisco to the East Bay could be hauled at a nominal cost because

of the large number of empty seats customarily carried on the trains and buses at this time. It would be desirable to develop such traffic from an operating standpoint. It would require:

1. Development of rapid transit within San Francisco, to reduce the travel time for San Francisco residents to the transbay terminal.
2. Adjustment of the fare structure to permit the trip to be made at a favorable price.
3. Development of a suitable bus feeder service in the East Bay with coordinated schedules.
4. Provision for parking in the immediate vicinity of the San Francisco terminal for the benefit of workers who desire to cross the Bay.

VEHICULAR TRAFFIC

In the statistics which follow the figures given are for vehicles unless otherwise specified. Figures given for persons riding in private automobiles have been derived by multiplying the number of automobiles by 1.9.

The following table shows the results of most recent auto occupancy survey, based on 16-hour counts for the day listed, and covering a total of 33,000 observed autos.

Day	Range	Average Passengers per Auto
Wed. 5-26-54	1.38 - 2.27	1.78
Sat. 6-5-54	1.75 - 2.53	2.20
Sun. 6-6-54	2.02 - 2.91	2.64

Composite Average for entire week = 1.96 which is believed high due to abnormal vacation travel and Sunday driving. A more realistic figure for average conditions on a yearly basis is 1.9.

Growth of Vehicular Traffic on Annual Basis

Vehicular traffic on the Bay Bridge now totals about 31 million vehicles per year. For the year ending June 30, 1953, some 30,887,808 vehicles crossed the bridge. This was almost exactly 5 million above the 1947 traffic volume. Traffic has been increasing at the average rate of approximately 1 million vehicles per year.

However, traffic saturation on the Bridge has now reached the point beyond which no appreciable increase in private vehicular traffic seems practicable under present operating conditions and with the present traffic pattern. For the year ending June 30, 1953, the increase in vehicular traffic over the preceding fiscal year was only 0.56% or about 1/2 of 1%. On the other hand, the fiscal year ending June 30, 1952, had a traffic volume of 3.47% over that of the fiscal year ending June 30, 1951. In previous postwar years the annual increase has averaged from 5% to 6%. In other words, vehicular traffic appears to have leveled off, at least temporarily.

Generally speaking, this record for 1953 was at considerable variance with the experience on other important highways in the Bay Area. For instance, traffic on the Bayshore Freeway at Burlingame (as indicated by 16-hour counts during a selected week in July) increased 19.4% during 1953 as compared with 1952. Using the same criteria, traffic over the Petaluma Creek Bridge on the highway around the north shore of San Pablo Bay was up

7.5% and traffic on El Camino Real at Palo Alto was up 6.0%. Also for purposes of comparison, traffic on the Golden Gate Bridge for the fiscal year ending July 30, 1953, increased 4.95% over the previous fiscal year, and traffic for the year ending June 30, 1952, was 10.7% above the 1951 fiscal year. Traffic across the Carquinez Bridge remained almost the same, based on the July traffic counts, but this is believed to reflect a drop in employment at the Mare Island Naval Yard and other military installations.

Note: The validity of using the selected weeks in July as indicating changes in yearly conditions is confirmed by observations of traffic on the Bay Bridge for these selected weeks. As previously stated, the actual total volume of traffic over the bridge during the entire 1952-53 fiscal year was 1/2 of 1% over the previous fiscal year, while the July counts indicated an increase of 3/4 of 1%, a close correlation for statistical data of this nature.

The period of the strike is not covered in the above statistics but during August, 1953, the second month of the strike, the average number of vehicles per day on the bridge was 94,963, while for the corresponding month in the previous year the average daily traffic volume was only 88,291. This average of 95,000 vehicles per day seems a practical maximum with the present traffic pattern. The maximum in any single day was 109,035 vehicles on September 18, 1953. This was accompanied by excessive delay and congestion in the approach areas.

It is of interest to consider the number of

persons crossing the bridge during the July-October transit strike. During June 1953, the last full month preceding the strike, the average number of train and bus passengers per day was about 41,000-- equivalent to 20,500 round trips. Since the number of vehicular round trips increased by only 5,000 per day on the average during the strike, it might appear that many persons were prevented from crossing the Bay during the strike. However, checks on the average number of persons per car and traffic counts on the Southern Pacific Ferry indicate little, if any change in the total number of people crossing the Bay due to the strike.

Relation of Vehicular Traffic to Motor Vehicle Registration

The increase in traffic on the Bay Bridge is lagging far behind the increase in motor vehicle registrations in the Bay Area counties. In 1946, for instance, the 584,000 vehicles then registered in the five Bay Area counties of San Francisco, San Mateo, Marin, Contra Costa, and Alameda made 25.35 million trips across the Bay, or an average of 43.3 trips per vehicle per year. Although the usage of vehicles per year has remained more or less constant, that is, each registered vehicle apparently is driven about the same number of miles now as it was in 1946, the 922,000 registered vehicles in the five Bay Area counties in 1952 made a total of 30.9 million trips across the Bay Bridge in 1952,

or an average of only 33.6 trips per registered vehicle per year. By July of 1953 the annual rate of crossings had dropped to about 32.5 trips per year--about 11 trips less per car than 1946. It should be kept in mind this decline in bridge usage per vehicle was accompanied by the simultaneous loss of mass transit patronage across the bridge.

These statistics indicate that the number of transbay trips per capita is falling off. In other words, in spite of improved methods of motor transportation, the average Bay Area resident makes fewer trips across the Bay than he did in 1946. It should not be inferred from the preceding that usage of the bridge on a per registered vehicle basis should remain constant. However, it is interesting to note that in spite of rising population and motor vehicle registration the total number of persons crossing the Bay has remained practically constant since the War.

Leveling Off of and Decline of Total Transbay Travel

During the fiscal year ending June 30, 1953, toll paying masstransit patronage on the bridge, both train and bus, totalled 15,491,950. This was a decrease of 9.92% in comparison with 17,186,425 passengers of the preceding year. Since the increase in vehicular traffic--0.56%-was negligible, it seems the number of persons (about 70 million) crossing the bridge during the year

ending June 30, 1953, was perhaps less than during the previous year. This appears somewhat surprising in view of the expanding economy of the Bay Area.

Characteristics of Vehicular Traffic During the Peak Hour

According to data for the afternoon of Friday, January 15, 1954, (See Appendix F), the maximum hour of automobile traffic westbound was between 4:30 and 5:30 P.M. and totaled 3,500. The maximum eastbound peak occurred between 5:00 and 6:00 P.M. and totaled 4,554. The completion of new approaches to the Bay Shore Freeway and to the Bay Bridge will probably shorten the time of concentration of rush hour traffic, and thus increase the intensity of the eastbound peak. On the other hand the eastbound evening peak is susceptible of diversion in part to mass transit, while the westbound is not, at least to the same extent.

Based on the above considerations it is concluded that to achieve the most efficient utilization of the roadway space on the bridge during the evening peak hour, the facilities provided for private automobiles at that time should be arranged as closely as possible in the ratio of 3.5 westbound to 4.5 eastbound.

Although the morning peak is sharper than the evening peak, it flows more smoothly, and therefore, does not need to be discussed in detail. According to data for Friday, January 15, 1954, the magnitude and time of the morning peak was as follows:

Westbound, 7:00 to 8:00 A.M., 4,610 Automobiles per hr.

Eastbound, 7:00 to 8:00 A.M., 2,294 Automobiles per hr.

Influence of Treasure and Yerba Buena Islands Traffic on Bridge Traffic at Peak Hour - The actual flow of traffic during the rush hour at the Toll Plaza is a good index of traffic conditions on the East Bay truss spans, but it does not accurately indicate conditions on the West Bay suspension spans. This is due to the large volume of traffic that leaves Treasure and Yerba Buena Islands at the rush hour. Traffic from the Islands destined to San Francisco is not counted and is not included in any of the traffic statistics, while traffic from the Islands to the East Bay is included in the statistics but is not actually present on the West Bay spans. In other words, during the evening peak hour the ratio of the traffic on the East Bay spans is approximately 3.0 westbound to 4.2 eastbound, while on the suspension spans west of the Island the ratio is probably more nearly 1 to 1.

The effect of traffic from the Islands is greatest at the crest of the peak. The situation can be materially alleviated, as was done by the Navy during the 1953 strike, by advancing working hours so that Island traffic would be off of the bridge before the crest of the transbay traffic. Improvement in this respect involves the Navy and its workers on the Islands and will depend on the level of military activities, which varies from time to time with the domestic and international situation.

Relation of Peak Traffic on Bridge to Capacity of Approaches - Generally speaking, the bridge as operated for the past several years has had slightly greater capacity that its approaches, except for wrecks or other blockage of the bridge. The capacity of the approaches prevents more than a certain number of vehicles per minute to gain access to the bridge structure like a limit valve in a hydraulic system. However, these conditions will soon be altered. Contracts for improving the East Shore Freeway northerly from the Distribution Structure, for expanding the capacity of the Distribution Structure, for providing more toll booths at the Toll Plaza and for completing the freeway along Cypress Street will eliminate the previous restrictions on the East Bay side. Likewise, the direct approach now under construction between the Bay Bridge and the Bayshore Freeway, as well as the planned Embarcadero Freeway and Terminal Viaduct, will increase the capacity of approaches to the San Francisco end of the bridge.

Thus, within a very few years the number of vehicles that can cross the bridge will be governed exclusively by the capacity of the bridge itself, and this in turn means that whenever hourly traffic during the rush period exceeds the capacity of the bridge, then traffic will back up onto the approaches.

Possibility of Diverting Peak Hour Upper Deck Traffic to Lower Deck - In recent months, the period of the strike excluded, the lower deck of the bridge has carried around 11,000 vehicles per week day while the upper deck has carriedaround 80,000. Thus, seven or eight times as many vehicles use the upper deck as the lower deck although the upper deck has only twice the number of lanes. This means the upper deck carries 3-1/2 to 4 times as many vehicles per lane as does the lower deck.

During the 1953 strike a considerable number of private automobiles were diverted to the lower deck but since then it is done only for short periods during the evening rush and limited to a few hundred private vehicles. Plans are now prepared for installing overhead signal lights on the lower deck to permit, among other things, unbalanced assignment of the three lanes. That is, it will be possible during peak hours to operate the lower deck with two lanes in one direction and one lane in the opposite. This practice offers a threat of complete blockage of all traffic in the event of a major accident on the single lane and will make it difficult for emergency vehicles to reach wrecks, stalls, or fires. Based on previous experience it is estimated that about 1,500 automobiles per hour in one direction can be carried on the lower deck at the crest of the peak in addition to normal bus and truck traffic.

Bus Traffic at Peak Hour - Bus traffic in comparison to the total vehicular traffic is relatively

insignificant. It constitutes only about 1.4% of the total number of vehicles. In 1952 Key System buses, 237,767, amounted to about 0.8% of the total vehicular load. Even if rail service is discontinued and buses substituted for the trains, the number of buses on the bridge would average only about 2 1/2 percent of the total number of vehicles. However, since the buses carry such a heavy percentage of the commuter load the increased number of busses during the peak hours will materially add to congestion. This matter of bus traffic on the bridge is discussed in detail in Part IV.

Reasons for Decline in Transbay Travel

As previously discussed, increase in traffic on the Bay Bridge appears to have halted, perhaps due to its limited traffic capacity and the question arises as to whether diversions to other proposed Bay crossings will change this picture. Accordingly, a discussion of probable diversion to the proposed Southern Crossing and to the Richmond-San Rafael bridge now under construction is pertinent.

Southern Crossing - During the 1953 Session of the Legislature a bill was passed requiring the construction of the so-called "Southern Crossing". Tolls on the existing bridge are to be used to help defray the cost of this new crossing. The act also provides that future maintenance expenses for transbay crossings shall be defrayed from bridge revenues.

There is difference of opinion as to the amount of traffic that will be diverted to the Southern Crossing. However, it has been estimated that about 20% of the existing traffic would be diverted from the Bay Bridge to a crossing terminating on Bay Farm Island. The percentage of diversion would differ with the hour of the day and the direction of movement.

It has also been estimated that two years will be required for making design studies and preparing plans and specifications for another such crossing. Another 5-1/2 years, according to previous estimates of the Division of Bay Toll Crossings, will be required before the first units of the transbay portion of the crossing can be opened to traffic. Taking into consideration the probable traffic growth during this 7 years, the total traffic using or wanting to use the Bay Bridge would be about 38,500,000 vehicles per year. With a 20% diversion traffic on the Bay Bridge would still be 30,800,000 vehicles per year--approximately the present traffic volume.

Actually, traffic on the Bay Bridge will probably be less than indicated above due to the limited traffic capacity of the structure. Nevertheless, this potential demand should appear when diversion to another crossing is possible. Hence, as experience also shows, completion of a new artery of travel will not solve the ultimate traffic problem on the Bay Bridge.

Effects of Increased Tolls - It is not possible at this time to estimate with any degree of certainty the tolls that would be required on the Bay Bridge to float a bond issue of the amount that will probably be required. Only a rough idea of the cost is known at the present time and future bond market conditions and rates of interest are uncertain. It has been thought possible that bridge vehicular tolls might have to be raised from the present 25¢ basic fare to at least 35¢. The Delaware River Port Authority, in refinancing the Philadelphia-Camden Bridge (a structure that carries about the same amount of traffic as the Bay Bridge) for the purpose of financing a new bridge across the Delaware River, found it necessary to increase the basic toll by 5¢ per vehicle for the new $100 million bond issue required. Therefore, it seems possible that it would be necessary to raise the basic toll on the Bay Bridge to 35¢ per auto if a bond issue of $200 million or more is required.

Such a toll increase would naturally cause a further diversion from private vehicles to mass transit. In the 1948 report of the Division of Bay Toll Crossings, Coverdale & Colpitts estimated an increase in toll rates from 25¢ to 35¢ would decrease automobile traffic by not more than 15%. If this lost vehicular traffic was all diverted to mass transit, the increase in the number of individual transbay trips would be about 22,000 per day.

However, this figure is obviously high, since prior to the recent strike the Railway carried only about 30,000 persons per day. An increase of 70% in train patronage due to this one factor alone appears unrealistic.

Richmond-San Rafael Bridge - Following the completion of the Richmond-San Rafael Bridge, now under construction, there will be some diversion from the Bay Bridge to that structure. However, based on O & D and other traffic counts, it appears the diversion will be comparatively negligible, say two or three percent of the Bay Bridge traffic. This diversion, however, may be offset on weekends by persons making pleasure trips around the north end of San Francisco Bay to ride over the Richmond-San Rafael structure.

Reasons for Transbay Travel Decline - It is of interest to inquire into possible reasons for the failure of total passenger travel over the Bridge to increase. There are a number of different factors or conditions to which this phenomenon has been attributed. The changes affecting community life described in the following paragraphs cannot be considered separately as the reason for, or the result of the transportation conditions on the Bay Bridge. Although it is important to distinguish between cause and effect, all factors are so closely inter-related that it is not possible to ascribe the condition of Bridge traffic to any single cause, or conversely, to say that

the bridge by itself has brought about the changes of habit noted in the adjacent areas.

Dispersed Growth - It is contended that the growth of the East Bay Area has been primarily on its southerly, easterly and northerly fringes--the Walnut Creek-Concord Area, San Leandro-Hayward, Richmond-San Pablo, etc., and that these localities are beyond economic commuting distance from San Francisco. However, although population growth in the East Bay, following the national trend, has been in the outlying suburban areas, this in itself does not explain the effects on bridge travel. Some of these areas are actually nearer downtown San Francisco than are many communities in Marin and San Mateo counties which are "bedroom" satellites of San Francisco. However, new suburban areas and recent real estate developments have not been located with the idea of convenient access to public transportation facilities in mind. Prior to 1930 most real estate subdivisions were so located but since then such access has been largely ignored by sub-dividers and property owners.

Moreover, new suburban developments have a relatively lower population density per acre--a condition that is not favorable for economical public transit. The development of American cities was once on the basis of 60 to 150 persons per gross acre, but since about 1920 they have been laid out for densities on the order of

10 persons per gross acre. As a result of this and the changes in living habits that have accompanied it, providing economical means of mass transit that is within convenient walking distance for thousands of persons residing in these widely scattered suburban communities seems impracticable.

Decentralization of San Francisco Central Business District - Many offices and businesses have moved out of downtown San Francisco to the suburbs, and it is argued there is less need for facilities crossing the Bay to San Francisco. In other words, it is contended a process of decentralization has set in. There is no doubt that the relative importance of downtown San Francisco as a retail center has declined, that some business offices have moved out of the central business district, and that some large stores have built branches in outlying areas. However, there has definitely been an expansion and continuing development of the downtown San Francisco business district as evidenced by real estate surveys and by the recorded increase of traffic from San Mateo and Marin Counties into San Francisco. Nothing is more likely to bring about decentralization of a downtown business area and destroy downtown property values than a situation which tends to separate the business area from its residential and industrial environs. Congestion on the Bay Bridge and its approaches and the breakdown of transbay public transit, is of course, such a situation.

Self-sufficiency of East Bay Communities - It has been contended that the loss of trans-bay travel can be attributed to the natural emergence of the East Bay cities as self-contained and self-sufficient communities which offer their own shopping, commercial, and business facilities, thereby lessening their dependence on San Francisco. Although this is probably true to some extent, experience elsewhere with traffic between twin communities has indicated that regardless of the self-sufficiency of each, there has been a general prevailing trend since the end of World War II for travel between the communities to expand.

Diversion to Alternative Routes - Traffic statistics indicate that there is now some diversion to other alternative routes from the Bay Bridge. For instance, a significant portion of the total traffic between San Francisco and the north central part of the State - Napa, Vallejo, Sacramento, etc. - travels via the Golden Gate Bridge in preference to the Bay Bridge. Likewise, there is some diversion over the San Mateo-Hayward and Dumbarton Bridges and around the south end of the Bay.

However, while many vehicles are diverted, statistics indicate that their number is insignificant in relation to the number using the Bay Bridge and in proportion to the overall transportation trend. The bulk of Bay Bridge traffic originates in or is destined to areas

etc., than would be the case if better transportation conditions prevailed. As a correlary to this hypothesis it is contended that the East Bay is no longer as desirable a place for San Francisco workers to reside as was the case two decades ago. The congestion does act as a deterrent to newcomers working in San Francisco who might, under better circumstances, reside in the East Bay. The economic effects of the situation can be illustrated by a variety of evidence. For instance, there are fewer residential rental units available in San Francisco than in the East Bay. This is reflected in a differential in the general level of rents between the two sides of the Bay so it might be expected that providing low cost, rapid transbay transportation would equalize these rentals. A casual inspection of certain areas convenient to the easterly bridgehead reveals blight where, under different conditions, one might surmise they would be developed as homes or apartments for San Francisco workers. The growth in the East Bay has been largely in the outskirts, whereas the proximity of the East Bay to San Francisco would be expected to promote the development of the adjacent areas as well.

Effects of National Economic Conditions on Transbay Travel - A study of past records indicates that travel across the Bay rises under favorable economic conditions, and falls off during periods of depression or recession.

Transbay travel reached a crest of over 45 million persons in 1928, and then fell off to a low of about 33-1/2 million in 1933. At this time such conditions can hardly be considered a material influence on transbay traffic.

FUTURE PATRONAGE OF TRANSBAY RAPID TRANSIT

It is conceded that cutting travel time and improving the frequency and convenience of service will stimulate transit patronage. But patronage is also dependent on numerous other diverse factors, such as population growth, changes in population centers, changes in travel habits, rate of development of central business districts, fare structure, comfort and convenience of the trip, relationship of transit fares to toll rates for private automobiles, traffic congestion on the Bay Bridge, future transbay crossings, location of terminals, fares charged on the San Francisco Municipal Railway, parking facilities, etc. It is beyond the scope of this report to attempt to evaluate the effect of any of the above factors, but certain assumptions must be made based on conditions which now exist or probably will exist in the future which may affect transit patronage.

For example, it may be assumed that any transbay mass-transit facility will be used mainly for regular travel to and from the San Francisco downtown area, and it is unlikely that public transit can compete with the private automobile for transportation to and from its

outlying residential, manufacturing, or recreational areas. It may also be assumed that the morning eastbound and evening westbound traffic movement (that is, San Francisco to the East Bay) is less susceptible of diversion to public transit than the opposite movements, since destinations in the East Bay are widely scattered. However, morning eastbound and evening westbound peak hour transit traffic will not impose any important controlling conditions on the design of a transit system. Then, if these assumptions are valid, the future level of mass-transit patronage will be in some degree related to the expansion and growth of the San Francisco central business district.

A recent real estate survey entitled, "Central City Property Values", by Paul F. Wendt of the Bureau of Business and Research, University of California, indicates that over the past 25 years only a comparatively modest expansion and growth of the downtown business district has occurred, and that the business district has participated only to a very minor extent in the tremendous growth of population, retail sales, and employment which has occurred in the Bay Area. There is little reason to expect that the next 20 years will witness any marked change in this prevailing trend. These observations conform in general to the situation in Los Angeles. In a report to the Los Angeles Metropolitan Transit Authority dated January 1954, prepared by Ruscardon Engineers in

cooperation with Coverdale & Colpitts, it was predicted that the total number of persons entering the Los Angeles central business district would remain relatively static over the next two or three decades, or that such travel would suffer a moderate decline.

There are a number of elements of similarity between the Los Angeles and San Francisco metropolitan areas, and in both there has been widespread decentralization of retail trade to outlying shopping centers. The general conclusion reached in the Los Angeles study are applicable to the probable future development of the San Francisco central business district. Although the latter is perhaps more stabilized than the Los Angeles business district, it still would be unrealistic to anticipate a large increase of travel into the San Francisco central business district or a spectacular expansion of the area. Therefore, even though the population of the Bay Area might be expected to increase as much as 50% in total population, only a 5% or 10% increase in total travel to and from the San Francisco central business district may take place.

Another assumption which seems reasonable is that the recent record of declining mass transit patronage does not necessarily indicate the future trend, particularly if worthwhile physical improvements are made to the existing transit system, and new transit facilities are placed

in operation where needed. The present outlook has been unduly affected by the public reaction to the recent strike and the successive fare increases and curtailments of service. From 1948 to 1954 the loss of patronage has accelerated, and if it continues, it is conceivable that mass transit across the bridge could become a negligible traffic component. The rate of decline seems abnormal and therefore, is not regarded as a reliable index of the potential transit demand under improved operating conditions.

A fourth assumption is that increasing vehicular congestion on the bridge will tend to increase mass transit patronage. In a report to the Toll Bridge Authority dated 1948, Coverdale & Colpitts stated, "The normal expectation would be, as the bridge becomes more congested, for more passengers to abandon the use of private automobiles, and use the Bridge Railway or Key System buses for the crossing.

Maximum Traffic in Peak Hour

An important matter to be considered is the upper limit (in terms of traffic during the rush hour) beyond which it does not appear necessary to provide transit capacity; that is, the probable maximum peak hour demand for which a rapid transit facility should be designed in order to serve the needs during the next two decades.

To decide this one must consider two possible sources of future transit patronage, namely:

1. Diversion of some of the existing vehicular traffic to the rails.
2. Overflow of future increments of transbay travel to the railway due to inadequate vehicular capacity of the Bridge.

1. Divertible Traffic - Based on previous traffic studies, it is estimated that 25% of the present vehicular traffic is destined to areas in the central business district which could be conveniently served by the bridge railway. Taking into consideration the average number of persons per vehicle, it appears an average of 30,000 passenger trips per average week day are potentially divertable from the present automobile traffic to mass-transit. This means that an additional 15,000 persons in each direction, with about 4,000 in the peak hours, might use the railway. This is somewhat less than the actual patronage on the rail lines in October 1952, when 16,800 persons used the Bridge Railway in each direction, with about 5,600 in the peak hour.

2. Future Growth - Traffic on other State highways within the Bay Area has been increasing as much as 4% or 5% or more per year, and population and motor vehicle registration are continuing to increase at about the same rate. There is nothing to indicate this trend will cease.

Therefore, it seems reasonable to suppose that potential traffic for the Bay Bridge is also growing - perhaps not at the same rate. Since the total number of automobiles crossing the bridge cannot be materially increased, this increasing traffic demand must either be fulfilled in some manner or throttled. It appears this demand can be met more expeditiously through expanded use of suitable rapid transit facilities.

This potential transbay passenger traffic is probably growing at the rate of about 2,000,000 trips per year. This means that if all persons denied access to the bridge in their private automobiles because of vehicular congestion are diverted to public transit, then patronage of public transit due to this factor alone should increase at the rate of about 2,000,000 persons per year. In five years this would be equivalent to about 5,000 trips in the peak hour. However, during the 1952-53 Fiscal Year transit patronage actually dropped 10% and is falling off even more rapidly now. Therefore, it is difficult to reconcile the general growth of traffic throughout the State and in the Bay area with the vehicular and transit record on the bridge.

As previously stated, past experience indicates the San Francisco downtown business district will not participate proportionately in the expected increase in population, employment, and retail sales expected within the

next few decades. Thus, there is little reason to expect any spectacular increases in the total amount of travel to and from its downtown business district, although a comparatively modest increase of about 25% in 1970 might be realistic. In general it appears possible that an improved rail facility might have to carry as many as 20,000 persons in the peak hour which corresponds to about 13,000 or 14,000 persons in the peak 1/2 hour. This can be compared to the original design capacity of 17,000 persons in a peak 20-minute period which apparently is ample.

PART II

INTERIM RAIL SHUTTLE

INTERIM RAIL SHUTTLE SERVICE

Coverdale & Colpitts in their report of May 15, 1953, on the Bay Bridge Railway, as well as several previous investigators, have suggested that an interim shuttle service be studied as a possible transbay rail operation. Under this plan passengers collected from along the present transbay rail routes and perhaps some of the bus routes would be delivered by bus to a shuttle terminal or terminals and complete the remainder of their trip to San Francisco via the Bridge Railway. Coverdale & Colpitts' findings are briefly reviewed herein at length.

Suggested locations for an East Bay terminal are: 1) the existing parking lot on Key System property at the intersection of Peralta, San Pablo, and Fortieth Streets (alongside the Santa Fe depot) 2) on the Key mole in the space now occupied by the Bridge Railway yard (alongside the toll plaza and approach to the bridge) and, 3) in the general vicinity of the tracks on Louise (near Peralta).

Shuttle Objectives

The objectives of an interim shuttle service should be:

1. To reduce to a minimum the number of autos and buses operating across the Bay Bridge, especially during the peak hour.

2. To provide speedy, comfortable, and convenient service that will induce additional mass transit patronage and prevent further diversion to private automobiles. (An interim operation which accelerated the decline in transit patronage would be detrimental to the future interests of rapid transit. Experience proves that patronage once lost is difficult to regain.)

3. To eliminate the present duplication of transbay service connected with collection and distributing passengers within the East Bay. (Shuttle operation should be integrated with the local transit lines and avoid separate bus lines serving San Francisco patrons as is now the case.)

It will be worse than useless to inaugurate an interim shuttle operation without taking all possible precautions to insure its success. Should its operation involve some confusion or delay, more and more patrons will shift to private automobiles. Shuttle operation requires an additional transfer for present Bridge Railway patrons and experience has shown that a transfer has detrimental effect on mass transit patronage. It is conceivable, therefore, that to let the bridge rails remain unused would be better than to operate trains under conditions that are not particulary attractive to potential patrons.

Previous Studies of Shuttle

A shuttle service between San Francisco and an East Bay terminal west of San Pablo Ave has been studied from time to time by other engineers. Detailed studies were made in 1941 for the Toll Bridge Authority by H. G. Weeks, Consulting Transportation Engineer, and more recently by the Key System engineering staff, both of whom recommended definitely against a shuttle service. The Toll Bridge Authority originally contemplated a shuttle operation when the Bridge Railway was being designed, but after additional study decided to provide for through rail service. On the other hand, consultants retained by the City of Oakland to prepare its master plan and by San Francisco to prepare a transportation plan have recommended in favor of a shuttle. However, those who have recommended in favor of a shuttle service do not support their proposal with as much substantiating information as those who have recommended against it. Extracts from, or short accounts of the studies and recommendations contained in previous reports will be found in Appendix A.

Coverdale and Colpitts' Study of A Shuttle Operation

In its 1953 report to the Toll Bridge Authority, Coverdale and Colpitts, discussed the probable cost of operation and revenues that would result from the operation of an "interim" shuttle service with a terminal near San Pablo Avenue. Its study was based on the following premises:

1. Passengers to be carried would be equal to those handled in 1952, including Yerba Buena Island passengers.

2. The terminal at San Pablo Avenue would be a temporary layout.

3. More frequent service would be provided than necessary for present or prospective traffic.

4. Rolling stock now in service would be utilized.

5. Operating expenses based on current methods and prices, but certain changes to reduce operating expenses might be put into effect. Some allowance was made for increased cost of service due to wage adjustments.

6. Revision of the Toll Bridge Authority contract with Key System could be negotiated.

Based on these premises, and assuming a 20 cent fare for the transbay trip, revenue from passenger traffic in 1952 was estimated to be $2,128,000, and expenses $1,807,000, an excess of revenue over expenses of $321,000. Assuming a ten percent loss in patronage under shuttle operation, estimated revenue was $1,915,000, expenses $1,807,000; or an excess of revenue over expenses of $108,000. However, subsequent to the report a strike of Key System employees occurred, causing a change in transbay travel habits which, together with an increase in the fare structure, indicates that shuttle patronage would be substantially less than estimated by Coverdale & Colpitts.

Experience with Shuttle Elsewhere

A rail facility somewhat similar to that of the Bay Bridge Railway is located on the Philadelphia-Camden

Bridge. This rail facility, five miles long, has been operated as a shuttle since the bridge was opened to traffic in 1936. Rail traffic has fallen far below expectations, with patronage dropping from around 10 million in the post-war years to 8.8 million for 1952. In recent months changes are being made to provide better transfer accommodations and through service into the Locust Street subway leading to downtown Philadelphia.

The Delaware Port Authority expects the connection to the Locust Street subway to increase patronage by about 2 million persons per year above the 8.8 million 1952 traffic volume, or an increase of 23%. While it is too early to determine whether or not these measures will prove to be successful, the disappointing experience of the rail line while operated as a shuttle shows the risk in converting the existing through rail service to a shuttle without proper terminal and collection facilities.

Shuttle Terminal Location

The basic criteria for selecting the location and designing the East Bay Terminal for an interim shuttle service are:

1. It must be economically located with respect to local bus and rail lines, and reasonably accessible to private automobile transportation.

2. It should have adequate space for storage of the extra rail units used only during peak hours.

3. It must have adequate storage space for the extra buses used only during the peak hour. (This,

preferably, should be close to some existing Key System storage.

4. It should be located where adequate private or public parking facilities are available in order to encourage commuters to park their cars in the East Bay and take the trains across the Bay.

5. It must have a designed capacity of about 10 million commuter trips per year and if it must also handle most of the existing transbay bus lines, the total commuter-trip capacity must be about 25 million per year, which in turn requires provisions for about 250 to 300 bus departures eastbound during the evening peak hour, with about 100 articulated unit arrivals during the same period of time.

6. It should be designed to permit a direct across-platform movement for the majority of passengers, with the minimum of congestion, confusion, and delay.

7. Because the operation is temporary, expenditures for capital improvements and land acquisition at the terminal should be kept to a minimum.

Since much of the Key trackage is in poor condition, the location selected should require the use of a minimum length of present trackage to avoid the cost of reconstruction. It is for this reason that the sites are in the general vicinity of the easterly bridge head. To locate a shuttle terminal closer to the downtown areas of Berkeley or Oakland or both would call for a greater expenditure than is considered practicable for a temporary expedient.

40th and San Pablo--The location most often mentioned for a terminal is on Key System property (owned by Railway Equipment and Realty Company, Ltd.) at 40th and San Pablo.

This parcel is bounded by Yerba Buena Avenue and the Santa Fe Railway depot on the north, Peralta and San Pablo on the east, and MacArthur Blvd. on the south. The property extends as far west as the Distribution Structure, but only its easterly end would be used for the shuttle terminal. The site is now occupied in part by Key System shops, rail spurs, and storage yards. The site is centrally situated in a busy downtown section. It is convenient to the bus lines operating on San Pablo Avenue and on MacArthur Blvd. but would require other buses crossing the Bay to detour from their present routes.

(There is some question whether the Toll Bridge Authority can acquire this property by eminent domain should it be needed by a utility under the jurisdiction of the Public Utilities Commission.)

Louise Street--A terminal in the vicinity of Peralta and Louise Streets in Oakland would be comparatively convenient and accessible for many Alameda and East Oakland commuters. For those served by the present A and B lines such a location would be preferable to the 40th and San Pablo location but it would be inconvenient for others.

On The Mole--In his 1941 report Consulting Engineer Weeks made a detailed study of layouts and revenues for shuttle operation between the San Francisco Terminal and a transfer terminal on the mole adjacent to the Toll

Plaza. Subsequently, this site for a transfer terminal was acquired by the U. S. Government for the Oakland Port of Embarkation and another large parcel was acquired by the East Bay Municipal Utility District for construction of a sewage plant. As a result adequate space on the mole no longer exists for a shuttle terminal of the size contemplated by Mr. Weeks.

There is space in the area formerly used by the Interurban Electric as a storage yard to construct a shuttle terminal of smaller proportions. This area is several hundred feet west of the Key System storage area and west of the Toll Plaza. This location could be used for a limited form of operation.

Although no information is available as to the number of persons who now park along Key System rail lines, it is believed the number involved would be greater than could be accommodated in the immediate vicinity of 40th and San Pablo or the other suggested terminal sites.

Relative Merits of Terminal Locations--The shuttle trains, being an interim expedient, will continue in service only until a complete Bay Area rapid transit system is in operation. Hence, capital expenditures should be kept to a minimum. Even if adequate space could be obtained on the mole, a large expenditure would be necessary to build overhead ramps and other facilities crossing the vehicular roadway to the terminal. An alternative plan involves a

somewhat circuitous rerouting of westbound bus traffic from 40th and San Pablo through the Key System subway to the Mole terminal. This would require paving the present railway through the subway. On the other hand, use of the 40th and the San Pablo location would permit conversion to shuttle service with only slight delay and with very little, if any, interruption of traffic. A location on the Mole would also be undesirable due to the lack of parking space for private automobiles. Finally, a location on the Mole involves additional "dead" trip mileage for the feeder buses, making the bus operation more costly, and possibly justifying an increase in fares.

There is a question whether it would be possible, in any of these locations, to design and construct - at moderate cost - a single shuttle terminal that could efficiently handle the large number of buses, trains, taxis, passengers and private automobiles (both parked and moving) that would be involved. Since the terminal should be designed for about 25 million commuter trips per year, with a maximum hourly capacity of about 250 to 300 bus arrivals and departures, it is possible that at least two terminals would be necessary.

As mentioned before, the Bridge bus and rail lines and the local East Bay lines provide some duplication of services. Obviously, this duplication is uneconomical and the service is less frequent; it should be

avoided as much as possible. Construction of a shuttle terminal in the vicinity of 40th and San Pablo on the Mole, or anywhere in west Oakland would be of little assistance in solving this problem. It would still be necessary to operate special bus lines to the shuttle terminals in addition to the local services which focus on the Berkeley and Oakland downtown areas. In only a few cases could the separate bridge lines be eliminated.

Cost of Terminal Property

The estimated cost of a terminal site at 40th and San Pablo is about $350,000 for a parcel containing 175,000 sq. ft.

Land values in the vicinity of Louise or Poplar Streets are somewhat lower, and a parcel containing 120,000 square feet could probably be obtained for $200,000 to $220,000.

For site along Poplar or Louise Streets it is estimated about 9 months would be required to terminate existing leases and remove existing improvements.

Shuttle Rolling Stock Required

Coverdale & Colpitts estimated that 35 articulated units would be required to provide a shuttle service between 40th and San Pablo and the San Francisco terminal. During the peak hour these units would be made up into seven trains of five cars each, operating on headways of about seven minutes. Ten additional units were recommended

as spares. However, due to the 25% decline in traffic since the report was released it is believed that seven trains of four cars each operating on seven minute headways could provide the service. The 37 units now owned by the Toll Bridge Authority would be adequate for both regular needs and spare requirements.

In the event it becomes necessary to acquire additional units from Key System, there are indications it values them at about $30,000 each. Due to the experimental and temporary nature of the shuttle, rental of equipment would be preferable to outright purchase.

Effect of Shuttle on Vehicular Traffic on Bridge

A coordinated service involving a transfer between bus and rail means additional time and inconvenience to the transbay commuter, and if all existing rail lines are converted to a shuttle operation, an appreciable number of existing patrons will be diverted to private automobiles. On the other hand, if all rail service is suspended and all-bus operation substituted there would probably be no diversion to private vehicles, but the number of buses on the bridge would increase. The question is which kind of operation, rail shuttle or all-bus, will result in maximum traffic capacity on the existing vehicular roadways.

Using 1952 figures, during the peak hour some 5,430 persons leave via rail from the San Francisco

terminal. With 48 persons per bus, this traffic load would require 115 additional bus departures during the peak hour from San Francisco. Since one bus occupies space equivalent to two automobiles, these additional buses would be equivalent to 230 additional automobiles.

If a shuttle is placed in operation, the increased time and delay incident thereto (say, three to five minutes in transferring) would probably result in some diversion to private automobiles. Coverdale and Colpitts state: "It would seem reasonable to expect a loss of about 10 percent in travel with a shuttle in operation." With 2.2 persons per auto (in the direction of heaviest travel during peak hours) shuttle operation would increase the peak-hour traffic (in one direction) by 250 additional automobiles. Although the figures are approximations they are sufficiently accurate to show that little or no alleviation of traffic will result from shuttle train operation.

Consideration should also be given to the effect of operating a shuttle service during the peak hours only. Difficulties involved in this plan are the use of employees on split shifts and confusion among patrons as to when and where to board mass transit vehicles in San Francisco. It might increase the total number of employees required to handle the commuter load, and in any event, would divert more commuters to private autos.

Hence, from the standpoint of lessening congestion on the bridge roadways, it appears there is little to choose between peak hour shuttle operation as compared to operating round-the-clock. Neither fulfills the intended purpose of reducing the vehicular traffic load on the Bridge.

Conversion of Transbay Bus Routes to Shuttle Service

Growing traffic on the Bay Bridge may at a later date force some of the transbay buses that now operate across the bridge to deliver passengers to the shuttle terminal. It would be relatively easy to re-route the following lines into a shuttle terminal in the vicinity of 40th and San Pablo.

"G" Solano-San Pablo Line
"H" Sacramento, Ashby, Folger Street Line
"N" MacArthur Line

Consideration might also be given to handling the following bus lines:

"K" East Oakland
"R" San Leandro
"O" and "W" Alameda

Because of the circuitous routing, the "J" and "L" (Richmond) lines do not appear to be adaptable to this shuttle operation and should continue to operate entirely across the Bay by bus.

The only benefit to be gained from re-routing some of the bus lines to the rail shuttle terminal would be to make additional space available for private passenger automobiles during the peak hours. The question is

whether this rerouting and discommoding of bus patrons would tend to accomplish the desired result which is to increase the overall traffic capacity of the bridge and alleviate vehicular congestion.

Present bus traffic on the lower deck is shown by the following record of bus traffic through the toll plaza on Monday, July 13, 1953:

Hour	East Bound		West Bound		Total, All
	Key Buses	Other Buses	Key Buses	Other Buses	Vehicles, Both Decks
7:00 to 8:00AM	41	29	111	23	7,357
8:00 " 9:00AM	13	25	60	22	6,421
4:30 " 5:30PM	112	44	30	17	8,307
5:00 " 6:00PM	123	29	36	17	7,769
Total for 24 hour period	391	375	391	417	88,653

Actually, Key buses absorb only a minor portion of the existing traffic capacity on the lower deck in one direction. The traffic capacity was estimated by Coverdale and Colpitts at 700 vehicles per hour in one direction. The 1953 load of 123 Key buses during the peak hour constituted only 18% of the theoretical one direction capacity of the lower deck as then operated. In no event can all buses be kept off the Bridge. Charter buses, Gray Line sightseeing buses, buses passing through San Francisco enroute to some other point, military buses, etc. would still need to use the bridge, and their passengers could not, as a practical matter, be diverted to a rail shuttle.

It will be noted that the number per day of "other buses" (buses owned by operators other than Key System) is about equal to the number of Key buses. However, because of the nature of the commuter service, the use of Key buses is concentrated in the morning and evening peak hours. On the aforementioned typical day, Monday July 13, 1953, 112 Key buses crossed the bridge in the eastbound direction between 4:30 and 5:30 P.M., but during this same hour only 44 "other buses" crossed the bridge eastbound. Since the estimated capacity of the lower deck as a part two-lane and part three-lane roadway is 700 vehicles in one direction per hour, the number of "other buses" was only about 6% of peak hour capacity. Compelling "other buses" to deliver their passengers to a shuttle terminal would of course, improve the load factor for shuttle operation.

It may be concluded that prohibiting some or all of the "other buses" from the lower deck during the peak hour and compelling all bus patrons to use the rail shuttle, (even if it were practical or legally possible) would contribute but little toward alleviation of peak hour congestion.

Frequency of Shuttle Service

Contrary to the expressed belief of many, a shuttle service would not in itself guarantee any increased frequency of service in the residential areas. A previous

study, apparently not based on adequate information, envisioned trains operating on 90-second headways, or 40 trains per hour. Units of 132 seats each, would provide 5,300 seats per hour in one direction across the bridge. However, during the off-peak hours the actual 1952 demand was only 400 to 700 seats per hour in one direction, bus patrons excluded. Thus, trains operating on such frequent headways would be 10% occupied even if there was no loss of patronage due to other factors connected with the shuttle. If all buses were required to deliver their passengers to the shuttle terminal, the number of passengers per hour would be increased somewhat, but even under these conditions it does not appear trains operating on 90-second headways would be more than 20% occupied during the off-peak hour. Operating trains on such a frequent schedule is uneconomical; no service operating with such a high percentage of empty seats could possibly hope to be self-supporting.

Using trains of one unit each, and assuming from 65 to 115 passengers in each 132 seat train as a reasonable load factor, trains can operate on ten minute headways and handle the present train patronage during the off-peak; headways would be decreased to seven minutes during the peak hour and if all Key buses were prohibited from the bridge the frequency of trains during the off-peak hours might be increased to one every five minutes. Ten

units theoretically could furnish this service during the off-peak hours. With a frequent operation of shuttle trains, feeder buses in the outlying residential areas--such as those served by the "B", "C" and "E" lines--could undoubtedly provide more frequent service than is now provided by the railway.

However, shuttle service on either a 5 or 10 minute frequency imposes difficult scheduling problems, and requires the operation of a large number of seats on transbay trains which will be only occasionally occupied. For example, one articulated rail unit could easily handle the passengers from two fully-loaded west-bound buses. However, if, as is possible, a bus is off schedule, misses the train connection, and arrives along with two following fully-loaded buses, then a single articulated rail unit which could otherwise handle the passengers will have a considerable number of standees, while the previous unit is running 2/3 empty. With the present service, either train or bus standees are relatively rare. Hence it might be necessary to operate two-unit trains across the bridge throughout the day, thus doubling the number of units and increasing the cost of operation.

Operation of Shuttle

The Toll Bridge Authority apparently has the power to contract with any responsible party for operation of a shuttle service. Cessation of rail operation by Key

System would terminate its present contract with the State. How the railway will be operated, whether by a private corporation or public body, is a matter of practicability and public policy, but it is assumed that the probable net revenue or net deficit from operation only would be approximately the same for either case. Hence, the figures used herein are assumed to apply to either public or private operation of the bridge railway as a shuttle line.

Costs of Operation

Estimated operating costs for a shuttle are contained in Coverdale and Colpitts Report. The July-October 1953 strike occurred subsequent to release of this report so the operating costs (due to wage increases) would probably be substantially higher than estimated by Coverdale and Colpitts, who conclude that operating revenues would probably offset costs.

Likewise, the patronage predicted by Coverdale & Colpitts does not now appear likely to materialize. It is still too early to appraise the permanent effects of the strike but all transit patrons having been forced to find other means of transportation, there is no doubt that many commuting habits were changed. This, together with the subsequent local fare increases, has evidently been detrimental to Key System operations. Thus, instead of the 10 percent loss estimated by Coverdale & Colpitts, it is quite possible that transbay patronage on a shuttle

service would be 25 to 35 percent less than that on the railway prior to the strike. It seems unlikely, therefore, that a satisfactory shuttle service can be operated without someone taking a substantial loss.

Estimated revenues for a shuttle will have to be based on 7.0 million transbay passengers or less, plus 1.6 million Yerba Buena passengers - assuming the latter are not diverted. If this assumption is correct, the estimated cost of operation would be some $2.0 million or more, while operating revenue would be $1.75 million or less - a net loss of at least $250,000 per year.

Coverdale & Colpitts mention possible economies in train operation, including a reduction in the number of men in a train crew and installation of turnstiles to reduce the number of ticket clerks and fare collectors. The reduction in crews is problematical but the deficit might possibly be reduced by the use of turnstiles.

Cost Estimates

The initial costs of inaugurating a shuttle service are estimated as follows:

Acquisition of Key System property at 40th and San Pablo, (if not possible to lease same)	$350,000
Construction of three stub-end tracks, bus loading platforms, shelters, fencing, etc.	500,000
Escalators in San Francisco Terminal	200,000
Working capital necessary to provide funds for operation	200,000
Say	$1,250,000

The Toll Bridge Authority could finance this only by the sale of revenue bonds. Apparently no other funds can legally be used for the purpose. To make the bonds saleable and to secure a favorable interest rate it would be necessary for the bonds to be secured by a lien on the revenues from Bay Bridge tolls which must also cover operating loss. As discussed previously, it is unlikely that a shuttle service can be operated at a profit.

Legal Considerations

In the event of discontinuance of rail service by Key System, it is the opinion of counsel the following conditions would apply:

1. The Toll Bridge Authority could legally contract with any responsible public or private agency for operation of the Bridge Railway, or could undertake the operation itself. However, there are no funds presently available whereby the expenses of this operation could be defrayed, and the only possible source of funds would involve a bond issue.

2. If it is desired to acquire the property at 40th & San Pablo for a shuttle terminal, but if Key System desires to retain this property for its own use, it is questionable whether the Toll Bridge Authority could take this property by eminent domain. Key System is a public utility providing an essential transportation service to the East Bay, and might contend this property is essential for that purpose.

3. Maintenance of trackage would be necessary in the event Key System discontinues operation. Since the Bridge Railway tracks can be considered as an integral part of the bridge, the cost of this maintenance, now borne by Key, would be a charge against bridge operation funds, which in turn are derived from Toll revenues under the terms of legislation enacted at the 1953 Session of the legislature.

4. The Toll Bridge Authority probably could acquire by eminent domain such parcels of property as may be necessary for a shuttle terminal or terminals except, as previously stated, in cases where such parcels are already owned by a public utility. However, additional or excess parcels cannot be acquired for the sole purpose of providing space for the parking of automobiles owned by shuttle patrons.

5. It appears the Bridge Authority could prohibit buses on the lower deck of the bridge at such times it deems such prohibition necessary for public convenience and safety. However, any effort on the part of the Toll Bridge Authority to take this action would result in a conflict with the powers exercised by the Public Utilities Commission, since no changes in routes or equipment can be made without express approval of the PUC.

6. It is believed Sections 30005, 30006, 30110, and 30111 of the California Toll Bridge Authority Act provide necessary legal authorization for the Toll Bridge Authority to undertake operation of a rail shuttle service.

Conclusions

It seems evident that shuttle train operation which only connects with present rail lines and possibly some bus routes, should not be undertaken except possibly as an emergency procedure. It must be a temporary expedient pending the adoption of a general Bay Area mass transit system. There is almost a certainty that such a service cannot be operated profitably and the loss in operation and an initial investment of over a million dollars must be provided for from public funds.

From the best available information, it appears that such a minimum-cost "interim" rail shuttle service would accomplish none of the objectives set forth at the

beginning of this section. Instead of decreasing vehicular congestion on the bridge, the increased diversion to private vehicles caused by the shuttle would tend to increase it. Instead of preserving transit patronage, a shuttle service would impair patronage and hasten the present downward trend since the service provided would be inferior to that which now exists or to an all-bus operation.

PART III

IMPROVED RAIL RAPID TRANSIT

IMPROVED RAIL RAPID TRANSIT SERVICE

The Bay Bridge was built primarily to provide better transportation service for the people of the Bay Area. The fact that the Bridge had to earn money to retire its indebtedness was a secondary, although essential, consideration. However, today--with vehicular traffic exceeding previous expectations, but with the actual number of persons crossing the Bay leveling off as the result of deterioration of mass transit service and saturation of the Bridge roadway by private vehicles--it becomes even more necessary to give special attention to the primary problem of transporting people

Adequacy of Bridge Railway

Each of the two tracks of the Bridge Railway has a potential capacity of over 50,000 persons per hour. It seems illogical to replace these tracks with a vehicular roadway capable of carrying not more than 2000 persons per hour per lane in private cars. There is little doubt but that the existing Bridge Railway has more than adequate capacity for any foreseeable future transit needs. It was designed for a capacity of 50,000 persons per hour using the now rather antiquated equipment which was obtainable in the early 1930's. With modern cars equipped

with more efficient brakes and more powerful motors, speeds could be increased and the minimum headway of 63 seconds decreased. If ultimately necessary, double-deck cars might be used to carry a still greater number of persons. As discussed elsewhere in this report, the maximum allowable speed on the Bridge Railway using modern equipment has not been determined, but it is believed the Railway can provide as fast transbay service as any other type of transportation -- buses, monorail, conveyor belts, or any other type of conveyance that has been suggested.

Since the Bridge Railway is a facility which, if it was provided with high speed connections and modern equipment, would be capable of handling the future transbay mass transit load, its possibilities and advantages should be given careful consideration before deciding to remove the rails and substitute some other means of transportation.

Present Rail Problem

The problem is how to get passengers to use the railway. Unfortunately, Key System or any other private corporation does not have the incentive to invest in new equipment and new lines. Operating within a narrow margin of expenses as compared with revenues, Key has had to request fare increases whenever expenses went up or patronage dropped, and this in turn only tended to decrease

the patronage. However, with the Bay Bridge now operating at full capacity and no relief in sight for the congested downtown areas, conditions may now be favorable for getting more people to use the rails.

It has been shown in a previous section of this report why an interim rail shuttle service operating from a practicable terminal in the vicinity of 40th and San Pablo would fail to accomplish its objectives. Halfway measures obviously can offer no solution to the mass transit problem so that continuation of the present service, inauguration of an inconvenient shuttle service, or operation by buses alone cannot arrest the general decline in transbay patronage or improve traffic conditions on the bridge. Increasing the capacity of the bridge requires either that the rails be replaced with roadway or that there be a drastic improvement in rail service to divert people from using private autos. This section studies the practicability of improving the existing railway with modern equipment and suitable collecting lines which would be an integral part of a Bay Area rapid transit system.

Any worth-while improvement of the Bridge Railway includes faster and more frequent trains, modernizing the San Francisco terminal, reduced fares and extending the rail lines in the East Bay on separated rights of way to main centers of population and travel origin. Although

the Railway could not be duplicated for less than $25 million, its present track connections and equipment make it practically useless as a means of solving the present transbay mass transportation problem; it is now a part rapid transit, part street car facility.

The general improvements and extensions of lines suggested in this report are considered the minimum improvements necessary to make the Bridge Railway an efficient transportation artery of a Bay Area mass transit system. The proper location of rail lines in the East Bay as suggested herein are mainly for purposes of illustration; final decision as to their location will depend upon the findings of the Bay Area Rapid Transit Commission and others studying the general transportation problem.

Basic Features of Rapid Transit

The present thinking of transportation experts is that the essential function of rapid transit is to permit long distance travel at high speeds through metropolitan areas with infrequent stops. Thus rapid transit means a trunk line which does not attempt to provide direct service to outlying areas. Service to these less densely populated areas is provided by surface feeder lines or private transportation. Therefore, if the Bridge Railway is to be continued, that is, if it is considered to be a better and more economical solution

for the transbay mass-transit problem than other possible methods, it should be reconstructed for such trunk line service. The problem is how far such a trunk line should be extended and where shall provision be made for bus feeder lines to connect with it.

It is essential to keep in mind that the Railway should serve not only as a means of transportation from East Bay residential areas to the San Francisco central business district, but also for travel from San Francisco residential areas to East Bay manufacturing, business, and educational centers. Thus, the problem of feeder service applies not only to the East Bay but is of equal importance to San Francisco. The geography of the East Bay being a long narrow strip between the shore and the hills, has in the past suggested the possibility of a main trunk rapid transit line running longitudinally through this elongated area. Such a trunk line, if ever built, will not necessarily affect the Bridge Railway problem since it can serve as a link in any such system, with cross-platform transfer if a different type of vehicle from that used on the Bridge Railway is adopted. Possible extensions of the Bridge Railway in the East Bay as described herein are intended to conform with the following objectives:

1) If an East Bay trunk rail line is to be constructed, portions of the Bridge Railway extensions can be incorporated in the trunk line if so desired.

2) If another East Bay trunk line of a type other than conventional rail is built, the railway extensions can intercept the East Bay trunk and provide convenient transfer points between the two transit systems.

3) If such an East Bay trunk line is not built, then the extensions will intercept East Bay bus feeder lines conveniently enough to permit continuation of the Bridge Railway as a transbay transportation artery.

Elimination of Duplicating Services

The Key System now operates two paralleling transit systems. Local lines perform the function of collecting, hauling, and distributing passengers within the East Bay while the transbay lines, to a limited extent, also collect and distribute passengers. This naturally results in some duplication of service. For instance, in Alameda, East Oakland and certain streets in Berkeley, local lines and transbay lines operate on the same streets. The situation is entirely different in San Francisco where Bridge Railway lines make no attempt to collect and distribute passengers. This function is performed by the San Francisco Municipal Railway routes which terminate at the bridge terminal building or which pass in close proximity thereto. However, the location of the San Francisco terminal could be improved since it is on the fringe instead of in the center of the business district. If the collection and distribution of passengers in the residential areas of the East Bay were undertaken by one system instead of by two, it should be

possible to improve the frequency and quality of service and lower operating costs by the reduction in operating mileage. This will require that the East Bay termini of the transbay lines be located at suitable collection points for the local lines, and that the Bridge Railway be extended on separated rights-of-way to these termini.

The need for direct rapid service to downtown Berkeley and Oakland seems obvious with, perhaps, another line to the Piedmont area. Numerous local bus routes now converge on these downtown areas and other lines could be intercepted by the Piedmont route. With transbay rapid transit serving such centers, the local bus routes would automatically furnish the feeder bus service necessary to the transbay transit operation, and thus permit partial or possibly complete elimination of separate Bridge bus and train service to outlying residential areas. A downtown Oakland station could serve Alameda, San Leandro, Hayward and East Oakland buses, while a Berkeley station could serve areas to the north and east. Intermediate stations could serve the San Pablo, Sacramento Street, MacArthur Boulevard, and all other lines with the exception of those operating to Richmond.

The suitability of these points as termini is indicated by past rail patronage which shows that the "A" Line serving downtown Oakland and the "F" Line to Berkeley are by far the most important. Therefore, it is apparent

that the expenditure for elevated or depressed structures, improved signals, etc., should be made on these lines to the downtown areas.

Physical Improvements - East Bay Approach

Construction of a rapid transit line to the East Bay downtown termini will require the acquisition, from Key System, of the trackage from the end of the Bridge Railway (west of the Southern Pacific tracks) through the subway and to a point slightly west of San Pablo Avenue. This trackage can be fenced and rehabilitated, and vertical curves through the subway beneath the Southern Pacific tracks can be adjusted to eliminate the present speed restriction of about 20 mph. Automatic gates could be installed at Hollis Street, the only intersection at grade. Beginning at a point west of San Pablo, the tracks could be depressed to pass beneath San Pablo and Adeline Streets. From this point a connection could be made by viaduct or depressed section to the general location of the future Grove Street freeway and another connection would be made to the present "F" Line on Linden Street.

Rehabilitation of "F" Line

On the "F" Line, portions of both Adeline Street and Shattuck Avenue are wide, and on these portions vehicular traffic does not interfere materially with the operation of trains. Reconstruction of the surface tracks

on this line, fencing, installation of automatic gates at important street crossings, and possibly closing other crossings would permit operation of relatively high speed trains, at least as a temporary expedient. The cost of reconstructing the "F" Line tracks from San Pablo to University Avenue is estimated to be about $800,000, and automatic gates would cost about $16,000 per crossing. With at least 10 sets of gates required, this would amount to $160,000. Adding $40,000 for the inter-connection of train circuits with vehicular traffic signals, to give the right of way to the trains, and another $500,000 for construction of one or two separation structures at the most critical locations, the total expenditure to improve the "F" Line to a useable interim standard would be about $1.5 million. The double track line beginning at the easterly end of state-owned trackage on the Mole and extending through the Southern Pacific Subway to 40th and San Pablo, thence along Linden Street, Adeline Street, and Shattuck Avenue to Dwight Way belongs to the Key System. Northerly from this point it is understood the tracks are owned by the City of Berkeley. The acquisition of Key System property would be subject to negotiation involving franchise obligations and rights of a public utility which is under the jurisdiction of the Public Utilities Commission.

It may also be necessary to acquire the Southern Pacific single track line located on Adeline, no estimate of the cost of acquiring any of these tracks and rights of way has been made.

Rail Line to Downtown Oakland

The narrow street widths on the "A" and "B" Lines are not suitable for a higher speed surface line and an entirely new line on separate right-of-way appears to be required. A suggested routing for such a rail rapid transit line to downtown Oakland is shown, in part, in the report, "Freeways and Major Streets, a part of the Oakland Master Plan," prepared by Harland Bartholomew & Associates in 1947. It is located in the median strip of a proposed Grove Street Freeway connecting downtown Oakland with downtown Berkeley. It might be feasible as an initial stage of a Grove Street Freeway development to purchase rights of way and to construct a rail transit line in a depressed section or on embankment and viaduct along the line of the Freeway. The rail roadway and its separation structures could be built first and the freeway portions at a later date. If, at some later date, the railway is found to be uneconomical the right-of-way, structures, and embankment might be used for the future freeway section with some modification.

The above mentioned 1947 report also proposed that the tracks enter a subway slightly north of 26th

FIGURE III-1
SUGGESTED TRUNK RAIL RAPID TRANSIT LINES IN EAST BAY, WITH POSSIBLE EXTENSIONS

on Grove, and from that point proceed underground to the Oakland central business district. While this is physically possible, it is doubtful whether a subway of the length required is the economical solution. A subway here would probably cost much more per mile than an elevated structure and a viaduct similar to that now used for the Bridge Railway loop in San Francisco should be considered. An elevated structure on separate right-of-way might permit multiple use of the land and provide other economies. An elevated structure on its own right-of-way need not interfere with light, air, or access to abutting property. Resilient wheels for the rail transit cars and use of sound-deadening material in the track construction can reduce the noise level to no more than that of a highway. The structure would be of a type similar to the elevated highway structures now being designed and built in San Francisco and Oakland.

While no studies have been made of possible locations for such a line in and through downtown Oakland, it is believed the cost of the structures alone, not including auxiliary parking or other facilities and not including rights of way, would not exceed $3 million.

The rail line could, and possibly should, ultimately be extended beyond the City Plaza to a terminal located somewhat south and east of the downtown area. To avoid delay on congested downtown Oakland city streets,

this ultimate terminal would be somewhere east of the 12th Street Dam in order to permit easy access for buses operating from the following points:

1) Alameda, via existing and proposed tubes on Webster and Harrison Streets.

2) Hayward, San Leandro, and other southeast points reached via the Eastshore Freeway.

3) East Oakland.

To summarize, the probable minimum cost of the initial phase of a rapid transit line from a point east of San Pablo and 40th Street to the vicinity of 14th Street only should be about as follows:

Rights of way, where required, assuming 85 ft. width of right-of-way required for depressed section	$1,500,000
Excavation of depressed section	700,000
Cost of separation structures and elevated structures	2,000,000
Elevated structure from Grove to vicinity of 14th Street, length about 3,000 ft.	3,000,000
Trackwork, electrical, stations, signals, etc.	2,000,000
	$9,200,000

Rapid Transit to Piedmont Area

Transit patronage on local bus lines indicates that a rail line providing convenient service to areas now served by the "C" (Piedmont) rail line, the "N" (MacArthur Boulevard) bus line, and possibly the outer end of the "B" rail line would be desirable. These three lines now contribute about 30% of the mass transit (train

and bus) patronage carried by Key System across the bridge, (Richmond lines are not included in the total). However, if the two rapid transit lines described previously, namely the Berkeley (Shattuck Avenue) and the downtown Oakland lines are built, some of this 30% would be diverted to these two lines. For instance, a considerable portion of the "B" rail line patronage originates at the intersection of Grand Avenue and Broadway or westerly thereof, and a rail line to Piedmont or along MacArthur Boulevard would not serve this traffic. Thus, 30% does not properly reflect the relative need for a line to the Piedmont-Central Oakland Area. Nevertheless, it seems that some type of rapid transit service should be provided which would intercept the important local bus routes on Telegraph, Broadway and Piedmont Avenue. Without this rapid transit line, either rail or bus, an additional transfer to reach one of the main rail lines would be necessary. The State has plans for a freeway which will parallel MacArthur Boulevard. Buses operating over this freeway, which should be constructed within a few years, would provide adequate transit service to those areas now served by the "N" bus line and the outer end of the "B" rail line. Buses could also operate to Piedmont via the proposed MacArthur Freeway, with the end of the run over city streets.

Thus, it is evident that construction of a rail line to this general area requires a detailed study before any decision can be reached. Pending such study, it will be assumed that service to this central Oakland-Piedmont area will be handled directly or indirectly by rail, and on this assumption the estimates of financial earning capacity, new equipment required, schedules, and required design capacity of the rail system will be predicated.

Terminal Building Modifications

To permit direct loading of the new or modernized cars it would be necessary to raise the loading platforms in the terminal building. There are four such platforms (A to D inclusive), each about 700' long. The outside platforms serve one track only, while the two inside platforms permit loading from both sides, thereby serving four tracks. In the initial stage only the two center platforms (B and C) would be raised to car floor height. The two outside platforms could be used for existing unmodified articulated rail units, when and if needed. If the volume of rapid transit traffic ever requires it, these two outside platforms can also be raised. The cost of raising two center platforms would be about $100,000 (which can be done without interference to train traffic). The cost of platforms at the other two stations on the Bridge Railway (Yerba Buena Island and Oakland Army Base), about $50,000.

Installation of Escalators

The platforms in the Terminal Building will be about 26' above street level and the installation of escalators is proposed as a desirable adjunct to a general modernization and improvement program. Since the building has three levels, two separate sets of escalators would be required, one between the ground floor and the mezzanine ticket floor (through openings provided in the original design of the building and now covered with removable concrete slabs), and the second set between the mezzanine level and the loading platforms. Initially, escalators would be installed to Platforms B and C only. Escalators would operate in the up direction only, since the existing ramps provide an easy grade for persons descending to the street level. Escalators could be located for the direct movement of passengers from the loading platforms to the loading platforms of a future San Francisco subway or other means of rapid transit located in front of the Terminal Building. The estimated cost for escalators is about $200,000.

Rail Car Storage in San Francisco

For maximum operating economy any plan should make provision for the storage of a large number of rapid transit vehicles in San Francisco between the morning and evening rush. The cost of dead-heading empty vehicles

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over long distances should be avoided. Unfortunately, the design of San Francisco rail terminal made no special provision for train storage but Key System does store about 12 articulated units in the terminal, this being possible because the number of trains operated does not require the use of the present six tracks. For the rapid transit plan contemplated herein, not more than four of the six tracks in the terminal would be used for loading and the remaining two tracks being used for storage. Also, only one of the two tracks around the loop is needed for train operation, so the other could be used for storage.

If the Bridge Railway could be extended to Sixth Street, as will now be discussed, then much of the loading would be done at the other stations on the extended line, and more tracks in the present terminal would be available for storage.

Extension of Bridge Railway to New Terminals

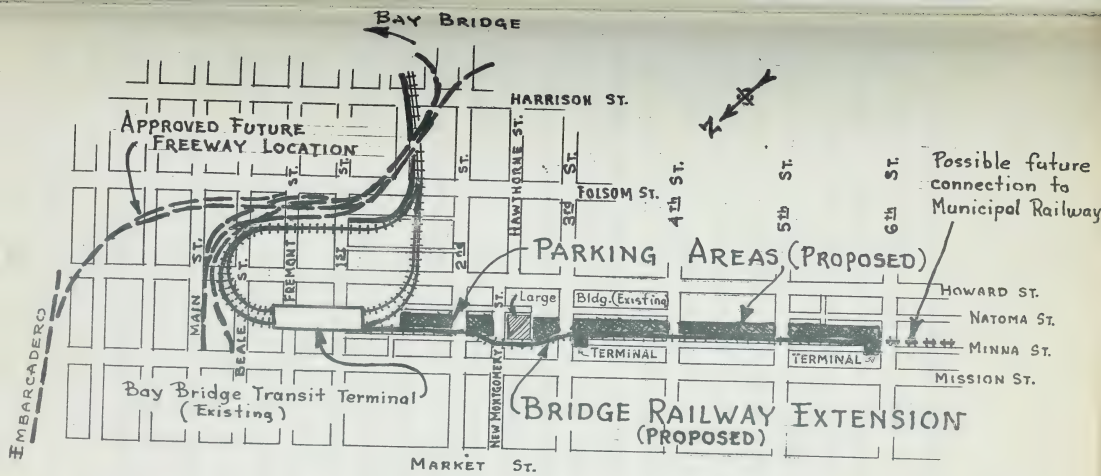
A difficult problem at the time the Railway was being designed was the selection of a terminal site in San Francisco. Numerous alternatives were suggested, but the location was determined primarily by the desire to provide a transportation facility of substantially the same scope as that offered previously by the ferry service, and the need to keep the overall cost of the Bridge Railway within the limits imposed by the available finances. The site selected on Mission between Fremont

and First is not at the most desirable location, being located on the fringe of the central business district and requiring patrons to continue to their uptown destination via streetcar. With a 50¢ cash fare on the Railway and a 15¢ San Francisco streetcar fare, the cost of a round trip adds up to $1.30 and the transfer requires additional time and inconvenience.

Another factor is that the center of gravity of vehicular movement to and from San Francisco has been shifting somewhat to the south and west. This indicates that as the years go by the destination of potential mass transit patrons will shift farther away from the present terminal building. From the standpoint of improving East Bay commuter patronage, it seems evident that extension of the tracks to a more convenient uptown location would be desirable.

Possibility of Extending Tracks in Subway - All of the various master plans and transit plans prepared for the City of San Francisco have called for a Market Street Subway, the main trunk of which would extend initially through the Twin Peaks tunnel. With one exception no plan advanced so far provides for direct connection of the subway with the Bridge Railway tracks, although the advantages of such a connection are recognized. The most recent official data indicating the location of the possible future San Francisco subway or rapid transit system

are contained in a report to the San Francisco City Planning Commission by DeLeuw, Cather and Company, Consulting Engineers, dated April 1950. The problem of making a direct connection between the Bridge Railway tracks and those of the San Francisco Subway is discussed in detail on page 12 of this 1950 report. It is shown that physical conditions make it extremely difficult, if not impossible, to construct the connection. Accordingly, a transfer station was proposed at the Bay Bridge Terminal, and a subway station would be located directly beneath the street level plaza now occupied by bus loading facilities of Key System. The report states the subway system is designed for integration into any future Bay Area rapid transit system. But even though no physical connection of tracks is made, the proposed subway would stimulate transbay transit usage. With the subway platform linked to the Bridge Railway platforms by escalators, commuters could transfer to the subway quickly and easily. Since the subway would cut travel times in downtown San Francisco, the overall time of transit for East Bay commuters might be reduced as much as ten minutes--depending upon the destination in the downtown area. However, direct extension of the bridge rail line on viaduct as discussed below may be more effective than the proposed subway in stimulating bridge transit patronage if it eliminates an additional transfer and fare in San Francisco.



PLAN

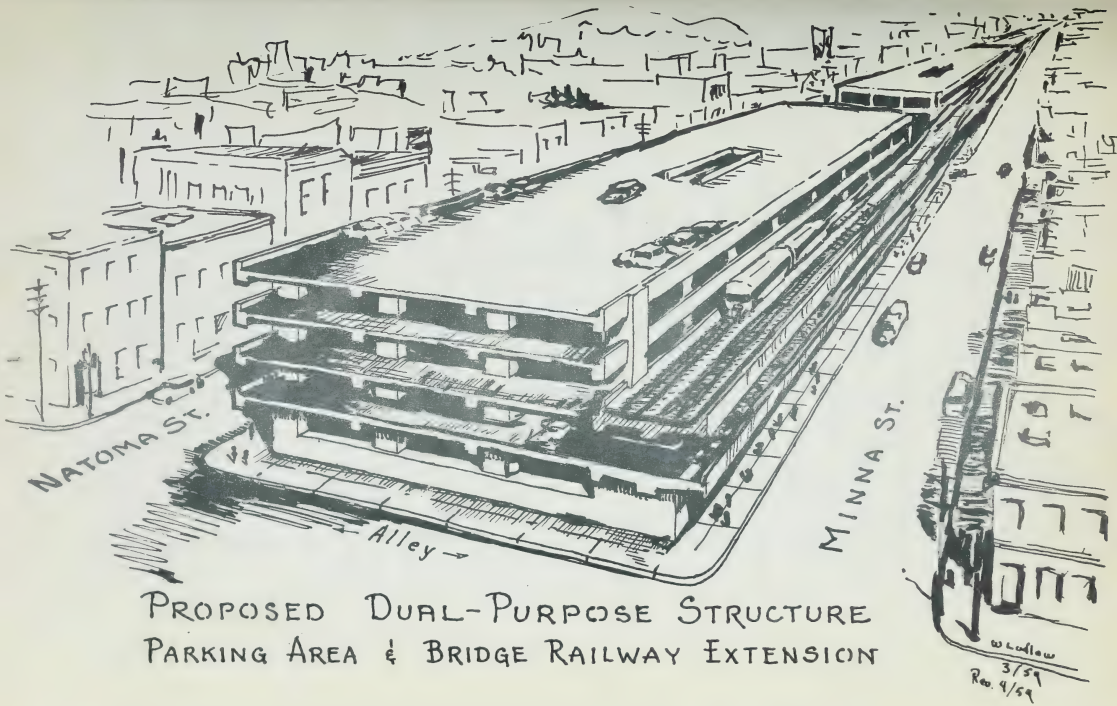
PROPOSED DUAL-PURPOSE STRUCTURE
PARKING AREA & BRIDGE RAILWAY EXTENSION

Extension of San Francisco Terminal Tracks - If the Bridge Railway tracks were extended, the desirability of viaduct in preference to subway seems evident. Also, the street layout and cost of real estate favor a location south of Market Street. One plan present a number of years ago envisioned an elevated line extending along Minna Street. Although this plan may today be unacceptable it does contain ideas adaptable to the present situation. In the report to San Francisco Planning Commission in November 1948, DeLeuw, Cather and Company and Ladislas Segoe and Associates recommended the construction of a series of off-street parking garages occupying a strip parallel to Mission Street and extending from New Montgomery Street to Sixth Street. Other planners have also advocated South-of-Market parking garages, in particular between Minna and Natoma. The possibility of elevated approaches to these parking garages has also been mentioned.

Thus, the possibility presents itself of constructing a multiple purpose project consisting of a series of parking garages, probably occupying the block between Natoma and Minna Streets, and extending from the Bridge Railway terminal building to Sixth Street, with space on the third level of the garage structures for the extension of Bridge Railway. Under this plan the cost of acquisition of this partially blighted property would be largely a charge against the parking facilities.

The cost of a viaduct for a distance of about 4,000' would probably be between $2,000,000 and $3,000,000 not including rights-of-way, the cost of which might be charged partly, if not entirely, to parking. The high cost of properties and a skyscraper building fronting on New Montgomery Street would require a slight deviation in the extended rail line and interruption of the parallel structures.

It is thought that more than 70% of the potential commuter patronage would use Third and Sixth Street terminals in preference to the present terminal. This is based on vehicular traffic counts and observation of the relative use of the present First and Fifth Street automobile off-ramps. Under this plan bridge trains entering San Francisco would make their first San Francisco stop to discharge passengers in the present terminal, and then would continue through the building to the Third Street and Sixth Street. The latter terminal would be provided with about three stub tracks and reversible cars. The trains would make the return trip with stops at the same three terminals to pick up passengers. The portion of loop trackage between Natoma and Folsom Streets now used by outbound trains would not be needed under this method of operation and would be available for off-peak storage. Four of the six tracks through the terminal building could also be used for train storage, cleaning, or other operations.



PROPOSED DUAL-PURPOSE STRUCTURE
PARKING AREA & BRIDGE RAILWAY EXTENSION

It should be observed that the existing railway terminal is actually a multiple-purpose facility containing a parking area of over 180,000 square feet which is space for about 800 to 900 cars--more than half the capacity of the Union Square garage. Including areas beneath roadways and approach ramps, there are now 17 separate areas under lease for parking purposes. The total usable parking area of 439,642 square feet provides space for parking 1648 vehicles. In recent years income to the Bay Bridge from rents and concessions, consisting mostly of income from parking facilities, has exceeded the tolls collected from Bridge Railway patrons.

If new terminals were provided, much of the floor area of the present Terminal on the lower levels would not be used. This includes the present waiting room on the ground floor since the mezzanine floor and head house could handle all traffic requirements. At present the ground floor waiting room is used by relatively few patrons either of the Bridge Railway or the buses loading outside. Nearly the entire ground floor waiting room having an area of about 25,000 square feet and worth not less than $250,000 could be released for offices, garage space, or other purposes.

Note: The San Francisco Police Department has proposed that the area between Minna and Natoma from Third to Seventh Streets be used for a parking garage. See San Francisco Chronicle, March 8, 1953. Use of this general area for parking was also advocated by the San Francisco City Planning Commission and the City Department of Public Works in a report dated Dec. 1946, entitled "Second Bay Crossing Study". The Planning Commission also contemplated use of this area as a loop suitable for express bus mass transit operation. The area included in the city report was bounded by Mission, Third, Howard and Seventh Streets.

Richmond Service

Richmond buses (J and L) operate via the Eastshore Freeway. These lines carry about 7 percent of the total Key transbay transit traffic. There is no convenient terminal to permit transfer from Richmond buses to Bay Bridge rapid transit trains that does not involve adverse distance and loss of time. Consequently, the service to Richmond should be the subject of further study, keeping the following possibilities in mind:

1. Continuation of the present bus service on the "J" and "L" Lines over the Eastshore Freeway and the Bay Bridge even though all other Key transbay bus lines might be eliminated.

2. Substitution of service by means of Richmond-Oakland local buses operating via San Pablo Avenue or the Eastshore Freeway, with transfer at 40th and San Pablo to Bridge rail rapid transit.

3. Ultimately service to Richmond could be provided via rail by means of self-propelled diesel cars operating on the Bridge railway and to Richmond via the Southern Pacific right-of-way or on a new rail facility to be constructed in the Santa Fe Railway right-of-way proposed for abandonment. These cars, it is believed, could operate over the double track Bridge Railway at satisfactory speeds, and would obviate the need for electrification of new or existing trackage.

Operation of a rail service to Richmond in lieu of the present bus service would reduce the number of bus departures from the San Francisco terminal to Richmond during the peak hour by only 22 - using 1952 traffic figures.

Rolling Stock

The rolling stock now used on the Bridge Railway has been described in Part I, and the advantages or dis-

advantages of these cars have been mentioned. It is apparent that if the Bridge Railway is to be retained in service, new rolling stock should be purchased and any of the present rolling stock retained should be modified to permit higher speeds. It is the usual practice on transit systems to operate the newer equipment throughout the day, while the older equipment is reserved to help carry the peak hour traffic load. Therefore, estimates will be predicated on the assumption that new equipment would be purchased for the off-peak demand only and that present equipment necessary to help carry the peak hour load would be modernized to permit somewhat speedier operation.

Number of Cars Required for Rail Transit Operation - Precise estimates of probable patronage using a modern rail rapid-transit service are not essential for the present discussion, (since the rail lines have more than adequate capacity for any foreseeable volume of patronage) but some estimate is desirable to indicate the cost involved in the purchase of new rolling stock, even though additional new cars can be purchased from time to time as the need arises. An analysis of the possible peak hour transit requirements based on 1952 conditions shows that a mass transit facility which will provide seats for about 6,200 persons during the peak half-hour period will satisfactorily accommodate all passengers

using rail lines in 1952 and all bus passengers except those on lines "L" and "J" (Richmond), and a portion of those using the "R" (Hayward), "O" and "W" (Alameda) Lines, who may be diverted to a Southern Crossing. For the purpose of this discussion the estimate of cost of new rolling stock and modification of the old will be based, therefore, on the figure of 6,200 persons.

New Equipment - New, modern cars with a more favorable power-weight ratio and with improved brakes will permit higher speeds both on the Bay Bridge and in the East Bay area. The cars should permit multiple unit operation in trains during peak periods. Two rapid transit cars of the ATA or PCC type permanently coupled together seat about 114 people (plus about 8 on folding seats) and weight 100,000 pounds as compared with 140,000 pounds of the present cars. Such cars are considerably more economical of power than the present cars. Track wear should be materially reduced, since the dead weight per truck would be reduced from an average of 47,000 lbs. to only 25,000 lbs. Additional data on modern cars will be found in Appendix D.

The present electrical transmission and feeder system has adequate capacity for all reasonable future transit needs and the 625 V. DC operating voltage is regarded as ideal for transit purposes.

Assuming there will be three main trunk transit lines previously described, rolling stock required to provide service with only new equipment during the off-peak period, with 10 minute headways on the Berkeley and Oakland lines, and 15 minute headways on the Piedmont line, would be as follows:

Grove Street Line to downtown Oakland	4 two-car trains	8 cars
Berkeley-Shattuck Line (University)	4 two-car trains	8 cars
Berkeley Line-Extension to Solano Avenue (optional)	2 additional two-car trains	4 cars
Piedmont Line	3 two-car trains	6 cars
	Total	26 cars

The foregoing estimates are based on the assumption that the round-trip cycle on the Grove Street Line will not require more than 40 minutes, and a round trip cycle on the Berkeley to University Avenue will not exceed 40 minutes, or if extended to Solano Avenue the cycle will not require more than one hour. For the Piedmont Line it is assumed the round-trip cycle will not exceed 45 minutes.

A review of Exhibits 21 and 22 in the Coverdale & Colpitts report indicates that during the off-peak hours, train service providing a passenger capacity of about 1000 seats per hour each way across the Bay would take care of probable bus and rail mass transit patronage and permit some expansion.

With the operating conditions described above, there would be 16 scheduled trains of 122 seats each per

hour in one direction across the bridge, providing a total of 1,950 seats per hour. It is evident this provides a comfortable margin over the required design capacity of about 1,000 seats per hour.

The above 26 cars, plus four cars as spares, would cost about $60,000 each, or a total of $1,800,000.

Modernizing Present Cars

For peak hour service, the present rolling stock is satisfactory insofar as comfort and seating capacity are concerned, but inadequate power does not permit satisfactory speeds to be attained on up-grades, and the type of brake used limits the speed on down-grades. Control on all cars is of the Type "M" (manual) originally designed in 1909. If new cars are purchased it would be uneconomical to provide the necessary electrical control equipment required to permit operation of the new cars in conjunction with the old cars; in other words, the new cars and old cars must operate as separate trains.

For outbound trains from San Francisco the short 4% grade and the long 3% grade make it difficult to accelerate the heavy articulated cars on these steep grades. For instance the total tractive effort or power requirement to accelerate to 35 mph in a reasonable distance would be about 700 HP. There are a number of ways to speed up the present cars on the grades. Of the 88 articulated units, the 23 that were built entirely new

by Bethlehem in 1936 have motors that are relatively modern in design. The remaining 65 units, all of which were rebuilt by Key System, contain motors 25 to 28 years old and are considered obsolete. Therefore, the 23 newer units can be modernized more economically than the older rebuilt units. Alternative means of speeding up the cars are as follows:

1. A modest increase in speed can be achieved by rewiring the motors of the 23 Bethlehem-built units to permit shunting of the field. These motors are provided with field taps, and by rewiring these cars can be speeded up slightly although with such rewiring they could not be operated with the other units. Speeds on up-grades can be increased from 20.5 mph to 22.8 mph, and the balancing speed on level tangent track can be increased from 38 to 39 mph to 46.5 mph.

2. For these 23 cars, it may also be possible, in addition to the rewiring mentioned above, to provide a new truck under the articulated joint to replace the present trailer truck and to change the gear ratio from 3.05:1 to 2.26:1. This would increase the power from 440 HP to 660 HP per articulated unit and the number of motors from four to six. Due to the present type of brake equipment, speeds on down-grades would be limited to about 40 mph, but theoretical speeds on up-grades would be increased to 32.4 mph and the balancing speed on level tangent track could be increased to 58 mph.

However, the manufacturer of the trucks, General Steel Casting Corporation, advises that the design stresses throughout the bolster and truck were generally up to the limit of accepted practice, and an increase in speed over that originally considered cannot be recommended. The manufacturer states that dynamic loads may under certain conditions of track increase in proportion to the square of the speed. The manufacturer's records indicate the maximum static deflection of the trucks, including both bolster and equalizer springs, amounts to only 3.85 inches. These facts indicate that satisfactory riding probably might not be obtained on these cars at speeds substantially higher than those now prevailing. If increased speeds must be considered, the manufacturer recommends that one unit be thoroughly tested for both riding comfort and truck stresses before any decision is made to alter all of the motors on all of the units.

The automatic devices used for cab signals and train control are now mounted on the trailer truck situated beneath the articulated joint. If this truck is to be replaced with a power truck, it would be necessary to relocate the train control equipment elsewhere on the car. Other work necessary would be 1) provide additional resistor capacity if new power trucks are added, 2) install new gears at a cost of $500 per motor or $3,000 per unit, and 3) some rewiring.

3. For the 65 older rebuilt articulated units more expense would be involved to secure improved performance. At the very minimum all new or rewound motors would be required together with a new power truck in place of the present trailer truck at the articulated joint. The cost of this work, if feasible, is estimated in the neighborhood of $30,000 per unit. Because of high cost this alternative is not recommended.

4. The power trucks, electrical control equipment, can be discarded and entirely new trucks with larger and more powerful motors together with better brakes, modern electrical control equipment, etc., can be purchased. However, due to the heavy weight of the present units, the estimated cost per articulated unit for such new motors and trucks would be in the neighborhood of $100,000 - not much less than for an entirely new pair of cars. Because of the high cost of reconversion as well as the high cost of electrical energy for such heavy cars, this alternative is definitely not recommended.

After reviewing the various alternatives with the idea of reducing the cost of operation and simplifying operation, it is thought that no effort should be made to modernize any of the 65 older, rebuilt units.* The Bethlehem cars should be considered for modernizing, and sufficient new rolling stock purchased to meet the

*Note: In the event a system of rail transit should be selected for certain routes on the system other than the trans-bay service--such as local service between Berkeley and Oakland--then there is some possibility the existing 65 rebuilt cars now used on the Bay Bridge could be employed in this service, at least during the peak hours. The old units would be more suitable for such use because operation would generally be over level track instead of on grades as steep as those on the Bay Bridge.

remainder of the transbay transit demand. These 23 modernized units would be semi-permanently coupled together into trains and used only during the peak hour. It appears that a new power truck under the articulated joint of each unit, with new gears for all motors providing a ratio of 2.26 to 1, might be a reasonably satisfactory solution to the problem provided satisfactory riding comfort can be attained and safe operating stresses are not exceeded. The modified units should also permit direct loading from platforms at car floor level which would require elimination of the steps and modification of the sliding doors. (Each unit now has four entrances, two right hand and two left hand.) And since these units would be used during peak hours only with several units in a train, the cars might also be modified (by moving the headlights) to permit passage of crew members from one unit to another, possibly reducing the number of employees required per train for multiple-unit trains.

The total cost of the modernization program as outlined above for the 23 units owned by the State, if such modernization is proved feasible, is roughly estimated to be $20,000 per unit, or $460,000.

It is thought that no effort should be made to improve the braking capability of the old cars. It might be possible to add magnetic track brakes, but this would

MODERN TRANSIT CAR USED BY CHICAGO TRANSIT AUTHORITY
(Photo courtesy St. Louis Car Company, St. Louis, Mo.)

increase not only the cost of the modernization work but also the weight of the cars. Thus, the advantages of increased allowable speeds on downgrades would be offset in part by loss of speed on upgrades.

Total Amount of Rolling Stock Required

On the premise that 26 new cars would be purchased to provide base service, and that only 23 of the existing units would be suitable for peak hour service, an estimate of the number of new cars necessary to handle the total peak hour demand may be made. As previously mentioned, it would be necessary to provide a capacity of 6,200 seats in the peak 1/2 hour, 2,900 seats on trains made up from the existing 23 units and 3300 seats on 54 cars semi-permanently coupled together into 27 two car units. The twenty-six new cars purchased for base service would be scheduled so that 16 would leave out of the San Francisco terminal during the 30 minute peak. This leaves a net of 38 new cars required for the peak hour service. Total rolling stock requirements are summarized as follows:

Base service, new cars.	26 cars
Peak hour service, new cars	38 cars
Spares, new cars.	4 cars
Total	68 cars
Estimated cost at $60,000 each.	$4,100,000
Peak hour service, remodeled old cars..	22 articulated units
Spare, remodeled old cars..	1 articulated unit

It will probably be several years before the above load develops and the various bus lines are all converted to rail, for which reason it may be desirable to purchase less new rolling stock than indicated above. The electrical power rate schedule for rail transit operations is primarily based on the peak hour demand and to a lesser extent on the actual consumption of electrical energy during the day for which reason the peak load should be kept to a minimum. This can ordinarily be accomplished only through using lighter cars which may justify the purchase of the new equipment. If new cars were not available to supplement the peak hour service, and the only new cars were those purchased for base service, it would be necessary to accumulate two-car trains in the San Francisco terminal, reassign train crews to the longer trains as they are made up, and then redispatch them. This would be a costly and inefficient procedure from the standpoint of operating manpower and might be prohibitive under union operating rules.

Train Speeds on Bridge

Coverdale & Colpitts in the report of the Division of San Francisco Bay Toll Crossings to the Toll Bridge Authority, "Additional Toll Crossings of San Francisco Bay", November 1948, comment as follows with respect to Bridge Railway patronage:

"One of the factors contributing to the relatively small traffic on the Bridge Railway is the time required for a trip. The use of a Bridge Railway requires almost half again as much time as a private automobile, so that a trip which requires approximately one-half hour by private automobile requires 40 minutes via Bridge Railway; and the trip that can be negotiated in approximately 40 minutes by private automobile requires an hour via Bridge Railway. The average running time on the bus line is substantially better than that on the Bridge Railway, but the trip time required is still 25% more than the time required by private automobile."

The Oakland City Planning Commission Staff in its report entitled, "The Transit Problem in the East Bay", March 1950, observed:

"The 6.7 miles of trackage on the Bay Bridge and approaches offer a unique opportunity for speedy operation. There are no grade crossings, visibility is excellent, and there are only two stops between the switching tower on the Oakland side and the terminal in San Francisco. In spite of these favorable conditions, the scheduled time for the trip is 19 minutes at an average speed of less than 25 mph. This is a very slow trip under such conditions."

It is generally believed that faster speeds on the Bridge and feeder lines would improve patronage; hence a study of the future rail transit service over the Bay Bridge must consider the maximum allowable speed of trains over the structure. Present train speeds are restricted by the automatic signal system to a maximum of 37-1/2 mph. This speed was dictated by 1) the apparent need at that time to provide maximum train capacity over the structure, with a minimum headway of 63 seconds, and 2) the necessity for restricting speeds on the down-grades in view of the braking power of the equipment then available.

A speed limit of 37-1/2 mph is consistent with the maximum speed of 35 mph of subway trains of conven-

tional design on down-grades of the Philadelphia-Camden Bridge, a suspension structure having spans comparable to those of the Bay Bridge. Actually, the present Key System cars do not have adequate motive power to take advantage of the 37-1/2 mph speed limit except on down-grades. Prevailing speeds of Key System trains on up-grades are about 20 to 25 mph. Modern cars of lighter weight and equipped with more powerful motors can be obtained that can climb the 3% grades of the bridge at speeds approaching 60 mph, and of course, at higher speeds on level. The question then is: What maximum speed can be tolerated on the bridge consistent with the safety of the structure and the travelling public?

Under present conditions the originally desired maximum train capacity is no longer needed and the system could operate with headways longer than 63 seconds permitting speedier operation for a lesser number of train movements. The expansion joints on the Bridge Railway are of unique design because of large movements which must be provided for and they result in abrupt changes in vertical curvature resulting in a break in grade of two or three percent at certain times due to extreme temperature conditions. These joints have required considerable maintenance since the bridge was completed. A recent inspection report by a consulting railroad engineer recommended that consideration be given to

issuing slow orders to trainmen when operating over these joints. Since there are 22 of these rail expansion joints on the bridge, this would necessitate a reduction in speed at 11 different points on each trip across the structure. It is not believed the design of the joints can materially be improved upon but the possibility has not been fully explored. As it stands, the joints are one condition limiting the operation of high speed trains over the bridge. Other factors which must also be considered are:

1. The necessity for minimizing dead weight which requires a light weight deck (non-ballasted construction).

2. Because of its vital importance, the possibility of structural damage to the bridge in the event of derailment of a long train operating at high speed must be seriously considered.

3. Track rails are 90 lbs. A.R.A. section but heavier rail could be installed if desirable.

4. The 20 degree curves of the San Francisco loop preclude operation at high speeds.

Because of these factors, the determination of a maximum safe operating speed on the bridge will require further study but it seems reasonable to suppose that if new, light-weight equipment is obtained, maximum speeds on the West Bay suspended structure could be increased to around 45 mph. Maximum speeds on the East Bay crossing could probably be increased to 45 mph on the cantilever portion of the crossing and 55 mph on all of the other truss spans. These assumptions as to speed will be used in the following discussion of improved rail

or rapid transit operation over the bridge. For portions of the Railway on land and for any proposed rail extensions, maximum speeds of 60 mph will be assumed. On this basis, assuming acceleration and braking rates of 3.0 MPHPS, the following table shows computed running times from the present San Francisco terminal to various points in the East Bay.

Theoretical Running Time Between East Bay and San Francisco, Using New Equipment on Separated Rights of Way

Mile	Station	Minutes Elapsed Time Including 15 Second Stops	Minutes Present Key System Schedules	Saving Mins.	Approximate Saving as % of Present Schedules
0.00	SF Terminal	0.00			
2.88	Y.B. Island	4.71			
6.19	Oakland Army Base (no stop for expresses)	8.56	14	5-1/2	40%
7.76	40th & San Pablo	10.48	19	8-1/2	45%
	Berkeley Line				
9.08	Alcatraz	12.07			
9.64	Ashby	13.12			
10.21	Dwight Way	14.45			
	Bancroft (no stop for expresses)				
10.78	University & Shattuck	15.65	33	17-1/2	50%
	Oakland Line				
8.48	Grove-MacArthur	11.91			
8.86	32nd & Grove	12.91			
9.24	26th & Grove	13.91			
9.44	Grand Avenue and Grove-San Pablo	14.66	24	9-1/2	40%
9.80	18th & San Pablo	15.66			
10.00	14th & San Pablo	16.41	27	10-1/2	40%

It is apparent that new rolling stock and new separated rights-of-way in the East Bay, to eliminate the conflict with vehicular traffic, can result in drastic time

savings, especially during peak hours. The actual time saving depends upon the type of rolling stock and the number of stops but it appears that running time can be cut 40 to 50 percent. Total time savings would amount to about 20 to 35 minutes in commutation time per person per day. However, more stops at transfer points along the East Bay lines will reduce these savings and patrons will lose time making the transfer.

The recently opened Dearborn-Milwaukee subway line in Chicago illustrates the effect of a rapid transit improvement which offered substantial time savings. Riding time between Logan Square and the Loop was slashed to fourteen minutes as compared with about 28 minutes for the former service via the "L". Within one year, average daily week-day traffic increased 75%--from 36,000 to 63,000 passengers per day. On a monthly basis traffic increased about 62% in less than a year. This increase represented in part diversion from parallel loop-bound bus, street car lines, and private cars with perhaps some increase in all traffic.

Minimum Headway in Peak Hour

The capacity of any rail facility is controlled largely by the minimum allowable headway between successive trains. This headway is selected as a safety measure to eliminate rear-end collisions. The present cars are equipped with standard air brakes which provide a rather

limited decelerating force. On modern electric cars any one or a combination of four different means of braking can be obtained. The operation of modern equipment is usually such that ordinary braking is done dynamically, that is, by using the propulsion motors as generators and absorbing the energy in resistors. The dynamic-brakes can be augmented by a drum or disk friction brake, by conventional air actuated tread or clasp brake, or by a magnetic track brake such as is used on PCC cars. With these various brakes deceleration of up to 4 mph per second can normally be obtained with higher deceleration under emergency conditions. This means that a train travelling at 60 mph can stop in 15 seconds or less.

Based on this, it is believed the minimum headway between trains of new cars could be reduced from 63 seconds to 35 or 40 seconds or less without danger. The cars would be equipped with cab signals of the type now used but set for the proposed speeds and headways.

Improved Frequency of Service

During 1952 frequency of service on week days on the several rail lines was as follows:

Line	Peak Hour	Off-peak
A - 12th Street	20 minutes	20 minutes
B - 22nd Street	20 "	30 "
C - Piedmont	20 "	40 "
E - Claremont	20 "	40 "
F - Shattuck	12 "	20 "

For the service under discussion trains could leave San Francisco at 5 minute intervals, with the trains alternating between Berkeley and Oakland. Thus, service as far as 40th and San Pablo would be provided on 5 minute headways, while in the East Bay downtown areas ten minute headways would prevail. Service on a Piedmont line, if built, would probably be on about 15 minute headways and since existing local bus service is frequent, very little loss of time should occur at transfer points. Thus for many train patrons frequency of service would be effectively increased from the present 20 to 40 minute headway during off-peak hours to about 10 minutes.

Service on the transbay bus lines is at 30 minute intervals or more during the off-peak hours. If all bus passengers (except Richmond, "J" and "L") are required to use the trains more frequent service for these passengers would be provided because local buses run more often, and hence provide more frequent feeder service. However, during rush hours the frequency of service now provided by transbay buses is better than could be expected with the train operation.

Readjustment of Fare Structure

Ordinarily, suburban railways charge a basic fare for the trip from the downtown terminal to a suburban terminal, and an additional fare for whatever local feeder service, if any, is used by the commuter between

there and his residence. Thus, a commuter has the option of going 1) via local bus between the terminal and his residence, 2) by auto to a parking area adjacent to the terminal, 3) by auto driven by a member of the family or others. The commuter who now uses private transportation to the Railway line pays for the distributive transit service which he does not get and this no doubt discourages transit riding. It would be desirable to adjust the fare structure to provide an incentive for patrons to drive their own cars to the transit terminal, which could be accomplished by breaking the 50¢ fare down into two components. If neither of the components exceeds 35¢, the present 10% Federal tax on a single cash fare would be eliminated.

Fare Differentials to Stimulate Traffic

Consideration might be given to establishing different fares for different times, in an attempt to improve the load factor on the Bridge Railway and to attract so-called "convenience riding" at the off-peak hours. Because of the large number of empty seats on any transit system during the off-peak, some authorities in the field of transportation have urged establishing lower fares for travel at such hours. The fundamental difference between the "must" rider (peak hour) and the "convenience" rider should be recognized and the fare structure should take it into consideration. The amount

of "convenience" riding is more directly influenced by fare increases or decreases than is "must" riding.

The following tabulation suggests a method of setting up different commute fares for riding at different times by means of different types of commute books.

Type of Book	Suggested Color	Number of Rides and Price
Unlimited commute-- For regular commuters living in East Bay	Green	4 rides for $1.00 (With extra "bonus" tickets good for riding at off-peak at reduced fare)
Reverse commute-- Commuters living in San Francisco and working in East Bay. Also Univ. of Calif. students	Blue	5 rides for $1.00 (Possibly with added coupons valid for parking on Rincon Hill at reduced rate)
Off-peak and weekend-- Good for riding at any time except during peak hours on weekdays	Pink	6 rides for $1.00
Regular cash fare	----	25¢

Need for Commuter Parking Facilities

It seems that an amendment of the Toll Bridge Authority Act would be necessary to permit acquisition of parking sites even though used exclusively for commuters. The effect of such parking facilities on patronage cannot be easily estimated. For some years Key System has maintained a parking lot at 40th and San Pablo, on which a fee of 25 cents is charged, but use of this parking lot has been disappointing. Although providing 150 parking spaces, it is seldom if ever filled to capacity. Whether parking lots of this nature would be

more popular if in a more convenient location is problematical. Key System has advertized the availability of free curbside parking along the rail lines, but it is not known how many commuters use this parking.

Main Line Rail Passengers - Possible Use of Bridge Railway as Shuttle in Lieu of Ferry or Bus

Southern Pacific - Western Pacific

As mentioned elsewhere, the State Public Utilities Commission ordered the Southern Pacific Company to submit a plan relative to substituting bus service for the present ferry service by which main line rail passengers are transferred between San Francisco and the Oakland Mole. In the event the Southern Pacific should at some future time discontinue the existing ferry service, and if the Bridge Railway tracks have not been removed, the railroad might desire to use a rail shuttle service instead of bus service as contemplated by the PUC. In this case the present Bridge Railway Terminal might be used as the San Francisco terminal for Southern Pacific and Western Pacific main line rail passengers. If buses are to be used and the tracks are not removed, then the railroads would be forced to acquire another suitable terminal in downtown San Francisco. This suggests the possibility of establishing rail connection between the Bridge Railway and the Southern Pacific Sixteenth Street Station to permit shuttling main line rail passengers between that station and the

San Francisco terminal. The San Francisco terminal could be modified at moderate cost to permit main line passengers to be handled and to handle baggage by installing elevators. This plan would make more efficient use of the Bridge Terminal Building and spread the pro-rata share of cost of maintenance of the building among several operators. It would also reduce the pro-rata cost of maintenance of Bridge Railway tracks and eliminate the possibility of delay to main line passengers due to traffic congestion on the bridge if buses were used.

Santa Fe - The Santa Fe Railway handles its main line passengers between San Francisco and its 40th and San Pablo Station in Emeryville via bus. The location of the Santa Fe depot immediately adjacent to the Key System rail line suggests the possibility of Santa Fe passengers using a rail transfer, thereby permitting the Santa Fe shuttle buses to be discontinued. However, the number of buses involved is quite small, and the effect on the lower deck traffic problem would be slight.

The above ideas are not a matter of immediate concern to the railroads or to the operation of the Bay Bridge. They are mentioned to indicate what could be done when and if it becomes desirable to do so.

Conversion of Existing Key Bus Routes to Rail

Increasing congestion on the lower deck of the bridge makes it desirable to convert as many trans-

bay bus lines as possible to rail operation. That is, several bus lines might deliver passengers to suitable rail transfer point in the East Bay area, and the commuter would complete his trip across the bay by rail. This necessarily adds an undesirable transfer but a number of transfer points could be used to avoid the congestion that would occur at a single transfer terminal such as that covered in Part II. All feeder service would be provided by local buses to eliminate separate local and transbay distributive and feeder services in the East Bay. The speedier trip afforded by the trains over the bridge, and the convenience of operating into the San Francisco Terminal or into new terminal facilities at separated grades, thereby avoiding the congested streets travelled by buses in San Francisco, might offset the disadvantages incidental to the transfer operation. Moreover, increased frequency of service could be provided by the combination of local buses and frequent bridge trains.

Possible locations for such transfer termini are as follows:

G Line (San Pablo) - Transfer at 40th & San Pablo. Service to be provided by local buses on San Pablo Avenue.

H Line (Sacramento Street) - Transfer at Market and Adeline, service to be provided by Sacramento Street - Market Street buses.

K Line (East Oakland) - Transfer at downtown Oakland Terminal, service to be provided by local buses.

C,W Lines (Alameda) same as preceding.

R Line (San Leandro-Hayward) same as above.

N Line (MacArthur Blvd) - To be determined.

L and J Lines - Through service to be continued via bus over bridge to San Francisco.

Conversion of Pacific Greyhound East Bay Bus Routes to Partial Rail Transit

Pacific Greyhound offers a commuter service across the Bay Bridge along two general routes, one operating through the Broadway Low-Level Tunnel to Walnut Creek and East Contra Costa County, and the other through Richmond to Vallejo and Napa. The San Francisco terminal is located on Seventh Street on the fringe of the central business district and buses must operate several blocks over city streets. These buses are now delayed during peak hours by the general downtown street congestion. Consideration might also be given to transferring the East Contra Costa Greyhound passengers to the rail line at a transfer station, say in the vicinity of Ashby Avenue and Adeline in Berkeley to complete their trip to San Francisco by rail.

With regard to the Vallejo and Napa service, the difficulty of finding a suitable transfer point would probably require this line to operate as at present. Also because of the baggage problem and other factors, buses engaged in inter-city service would also continue to operate into San Francisco as at present.

Passengers on the two Greyhound commuter routes in 1951 were (figures include both transbay and non-transbay travel):

San Francisco, Oakland, Walnut Creek, etc. 1.77 million

San Francisco, Oakland, Vallejo, Napa, etc. 1.06 million

Time Required to Construct

The rapid transit plan discussed herein could be undertaken in stages, and the work can proceed without interfering much with existing rail service. Each portion, when completed, can be put into use; for instance, installation of electric stairways in the Terminal Building could be completed within a few months, as could also modernization of the existing rolling stock. New cars, if placed on order without delay, possibly could be delivered by the time rehabilitation of the "F" Line to Berkeley is completed. Construction of a line on separated grade to downtown Oakland would probably require the longest period of time, possibly four years, although a usable portion might be available sooner.

Recovery of Investment for Rail Transit Improvements

Pending the final results of area wide rapid transit studies, it will be arbitrarily assumed in considering the economics of an improved rail service that the specific improvements mentioned, together with adjustment of fares, probable increased tolls on new bay crossings, congestion on the present bridge, etc., will

develop an annual patronage of 25 million during 1957, assumed to be the first year of rapid transit operation. This may be compared with the 13.9 million toll paying passengers per annum who were using Key rail and bus lines, (Yerba Buena Island and Richmond excepted) during the first half of 1953. It may also be compared with the 35.9 million toll passengers on the Key transbay lines in 1945.

As previously stated the Bridge Railway (including rolling stock owned by the State) now has a book value of about $14,919,000 and a depreciated value of about $12,800,000. However, toll receipts from train passengers now total less than $125,000 per year -- only a fraction of the amount required for interest on the investment. Most of this investment must be written off if the rails are removed and the bridge is redecked, or else a substantial sum of money must be invested in additional improvements to re-equip, modernize, and extend the railway. The rail facility in its present condition must be considered to have no earning capacity and its salvage value in this case is small. An analysis of the financial merits of improving the Bridge Railway must be based on recovery of the additional investment only, and the present book value must be regarded (like the former investment in ferry boats) as an item of "sunk cost". Assuming the improvements are made, train

tolls will continue to be collected and with the greater mileage an increase in tolls from 1-3/4 cents to about 3-1/2 cents per trip seems reasonable. (This increase in train toll is only a fraction of the amount of the Federal transportation tax.) Assuming patronage will reach 25 million patrons per year, the total annual railway toll revenue (exclusive of operating revenues) would be around $900,000 per year. At 3% interest, this would be sufficient to amortize a $15 million additional expenditure in 20 to 25 years, and the transit improvements would not have to be subsidized by tolls collected from motorists.

Subsidizing A Mass Transit Facility - However, it may be unrealistic to expect at the start that revenues will be sufficient to meet operating expenses and also amortize the investment. Shifts in population and travel habits that will increase public transit cannot be expected to occur over night immediately upon the inauguration of better public transportation. Therefore, to prevent a spiral of increasing fares and decreasing patronage, some assistance from other Bridge revenues may be needed for a time to get the Bridge Railway on its feet. However, if the patronage can eventually be expanded from the pre-strike volume of 13.9 million to over 25 million, then revenues will probably equal direct operating expenses.

If the above mentioned volume of traffic fails to materialize, and if some form of a "subsidy" by vehicular traffic does prove necessary, it may be justified on the premise that the Railway improves the vehicular traffic situation on the Bridge, particularly during rush hours. For example, in 1952 an estimated 55% of transbay rush hour commuters (in the peak direction) traveled by transit and only 45% by private auto. If mass transit service was not available and commuters forced to use private automobiles it would greatly increase the congestion on the Bridge, and eventually require construction and maintenance of additional vehicular crossing facilities needed only during the peak hours. It should be immaterial to motorists whether freedom from congestion is gained through additional roadway capacity or through the construction of rapid transit facilities. In either case the objectives are the same. A practical means of financing any deficiency in net earnings of the railway would be to collect a toll of, say 1.5¢ from transit patrons (in the same manner as the present 1-3/4¢ toll is collected) with payments to the Bridge contingent on earnings of the rail operation. This arrangement is used on the Philadelphia-Camden Bridge, the operator of the rail transit line on that structure being obligated to pay to the Bridge Authority the specified passenger toll only if earnings are sufficient. For the past

several years full payments have been made, but when the rail line was first opened to travel some aid was necessary.

Cost of Operation

The cost of operation of a rapid transit system is frequently expressed in terms of cents per car mile. This includes operating expense, station costs, power, supervision, maintenance of track and equipment, and other expenses. The cost of operation depends, in part, on the ratio of variable operating expenses, such as power and labor, to fixed expenses, such as station costs. For this reason, the greater the operating mileage the less the cost per car mile.

For 1952 operating costs for bridge trains on the portions under Toll Bridge Authority ownership indicate a cost per unit mile of about $1.18. This is based on 3,500 articulated unit trips per week over a distance of 6.8 miles at a cost estimated to be $1,466,000 by Coverdale & Colpitts. Since 1952 the number of miles operated have been reduced, but wages have increased and other costs including maintenance of track, power, station expense, and accident insurance and general administration have not been reduced in proportion. Therefore, it is probable the cost per articulated unit mile on the Bridge Railway itself is now somewhat in excess of $1.25, or $0.62-1/2 per car mile.

In the following estimates of future operating costs for a modernized rail transit system, it is assumed

that a two-car train of the newer type would be equivalent to one articulated unit, but that the lighter cars and higher speeds of operation with the saving in manpower by eliminating fare collection on the trains (using turnstiles instead) would reduce these costs. On this basis a total cost of operation per car mile is estimated to be about $0.45. The cost of operation for the proposed monorail line as given in the report of January 15, 1954, by Coverdale & Colpitts for the Los Angeles Metropolitan Transit Authority was estimated to be about 37.2 cents. This included maintenance of way and structure, maintenance of equipment, operational costs, general administration, power, social security and compensation and other insurance. The proposed monorail system would operate at about the same speed as the conventional rail system proposed in this report and operating costs should be about the same.

Assuming two main trunk lines in the East Bay and no standing during peak hours, a tentative train schedule has been worked out which indicates the following car mileage requirements:

	Annual Number of Car Miles
Level of transit patronage equal to 1952 rail and bus patronage	5,700,000
Transit patronage equal to 1952 rail and bus plus 50%	7,270,000

For purposes of comparison, Key System before the 1953 strike operated about 2,000,000 unit miles annually, equivalent to 4,000,000 car miles.

Results of Operation

The following shows possible revenues for a rapid transit rail operation, assuming the same ratio of peak to off-peak hour traffic and no standees.

Annual No. of Patrons (Millions)	Operating Revenues @ 16-1/2¢ per Passenger	Annual Car Miles Req'd	Annual Operating Cost @ $0.45 per Car Mile	Net Profit
18.3 (above equal to 1942 patronage, rail and bus total)	$3,020,000	5,700,000	$2,560,000	$460,000
20	3,300,000	6,000,000	2,700,000	600,000
25	4,120,000	6,800,000	3,060,000	1,060,000
28.45 (above equal to 1942 patronage, rail and bus, plus 50% increase)	4,730,000	7,270,000	3,270,000	1,260,000

Note: Assumed average basic fare, 20¢. Train tolls of 3-1/2¢ per passenger payable to Bridge to cover pro-rata share of interest and amortization on bonds used to finance rail improvements.

The above estimates of future operating costs appear low in comparison with present Key System operating costs but the following factors should be kept in mind:

1. Cost of maintenance of new rolling stock and new track should be less than for old equipment and surface tracks in the East Bay.

2. With shorter travel times, less equipment and fewer employees would be required to carry the same number of passengers during the peak hour.

3. The ratio of revenue per car hour to costs of operation per hour should be materially improved.

4. Under public operation, certain taxes would be eliminated.

5. With new light-weight equipment, power costs would be reduced.

6. Greater density of traffic distributes fixed costs, such as station employees, track walkers, tower operation, etc., over a larger number of car miles of operation, thereby reducing the cost per car mile.

7. Trunk line operation is inherently more economical than the present operation with duplication of transbay and feeder facilities of Key System. This is illustrated by data contained in Coverdale & Colpitts Report of May 1933 to the Toll Bridges Authority which shows that 55% of the car miles of operation but only 46% of the expenses of operation were chargeable to trackage under Toll Bridge Authority ownership, while 45% of the car miles and 54% of the costs were accumulated on trackage owned by Key. This indicates the cost of operation per car mile on the East Bay feeder lines is about 44% more than on the bridge itself, which may be considered a trunk line.

The foregoing table shows the results of operation if operating costs can be reduced to $0.45 per car mile. If, however, the cost of trunk line operation proves to be about the same as the present cost per car mile on the bridge Railway itself, estimated at $1.25 per unit mile or $0.62-1/2 per car mile, the following tabulation shows the result:

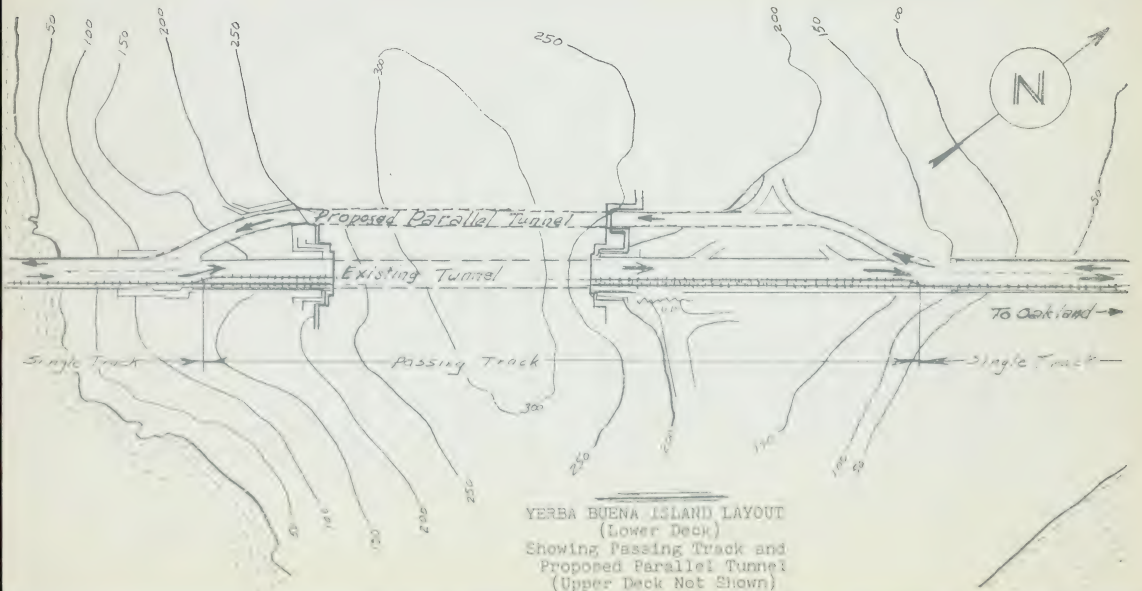
Annual No. of Patrons (millions)	Operating Revenues at 16-1/2¢ per Passenger	Annual Car Miles Rec'd	Annual Operating Cost @ $0.62-1/2 per Car Mile	Net Deficit (See Note)
18.3	$3,030,000	5,760,000	$1,560,000	$510,000
20	3,300,000	6,000,000	3,050,000	450,000
25	4,120,000	6,800,000	4,250,000	130,000
27.5	4,530,000	7,270,000	4,540,000	$ 10,000 (Profit)

Note: The aforementioned so-called "deficit" could be covered by taking advantage of the contingent payment feature of the train toll of 3-1/2¢ per trip, as described previously, which would be payable in full to the Bridge only when earnings warrant.

Cost Estimates

The tentative costs given in the preceding discussion are collected here in order to give a general idea of the probable magnitude of the minimum expenditure necessary to construct a rapid transit rail system connecting with the City mass transit lines.

Rolling Stock	
Modernizing 23 articulated units for use during peak hours	$ 460,000
New cars, 68 required	4,100,000
San Francisco terminal	
Escalators	200,000
Loading platforms, (raising)	100,000
Extension of tracks to new terminal	3,000,000
Rail Line Improvements in East Bay	
Loading platforms at Island and Army Base	50,000
Improvements on trunk line from end of Bridge Railway on mole to University Avenue in Berkeley	2,500,000
Rapid transit line to downtown Oakland	9,200,000
Piedmont line	(Not included)
Total	$19,610,000
Say	$20,000,000
Deduct pro-rata share of cost of East Bay lines used for local service as well as for transbay service, if any, ...	To be determined



YERBA BUENA ISLAND LAYOUT
(Lower Deck)
Showing Passing Track and
Proposed Parallel Tunnel
(Upper Deck Not Shown)

Legal

Under existing statutes finances for extending the Bridge Railway would have to be obtained by the Toll Bridge Authority from the proceeds of the sale of revenue bonds. Financing a rail transit system by revenue bonds based solely on its earnings is apparently impractical. If backed by earnings of the Bay Bridge, authorization to refinance would be necessary. Improving the railway will not require new rights of way on Yerba Buena Island, and the work probably can be prosecuted without the necessity of congressional action or obtaining encroachment permits from Federal authorities. Special enabling legislation would probably be required for a public agency to undertake operation of the proposed rail line. It is possible that the State could legally operate the Railway under existing laws, but for practical reasons and since the Bridge Railway is but a link in the Bay Area transit system, it seems desirable to form a local agency for this purpose as has been done in other large metropolitan centers. It is beyond the scope of this study to discuss the administrative and legal phases of policy and legislation involved in setting up such an agency.

SINGLE TRACK RAILWAY WITH FOUR LANE ROADWAY

The possibility of modifying the Bridge Railway to operate portions on an interim basis as single track and thereby add one lane to the present three lane roadway has been considered. It would require construction of a parallel viaduct between Rincon Hill and the San Francisco anchorage, and a parallel tunnel on the Island, in order to have a full four-lane vehicular roadway throughout. At the present time Key System successfully operates two lengths of single track on the Shattuck Avenue (Berkeley) "F" Line, and short sections of single track on the "B", "C" and "E" Lines.

Changed conditions as previously discussed suggest the possibility of converting portions of the Bridge Railway to single track operated by a system of Centralized Traffic Control (CTC). Many main line steam railroads use CTC on a single track line instead of double tracking, thereby avoiding capital outlay, higher taxes and higher maintenance costs. The feasibility of single track operation in transit service as well as on main line railroads depends on the number of train movements and so a CTC controlled single track on the Bay Bridge may work if the number of rapid transit lines are limited and can operate on accurate schedules but is impossible under present operating conditions. This plan contemplates two lengths of single track each about

two miles long, one located on the East Bay truss spans and the other on the West Bay suspension spans. On the Island the present section of double track about 1500 feet long would be retained to permit passage of east and westbound trains. Since all trains must stop on the Island, this is an ideal point for passing.

Traffic Design Criteria for Single Track Plan

The capacity of a single track transit line to handle the future transit load for a certain number of years requires an estimate of the probable peak-hour or half hour volume at some given date. The rail transit load prior to the 1958 strike, 5000 persons or less per hour in one direction, is probably not a very good indication of future requirements. The future situation must consider the possibility that some of the present transbay bus passengers would be diverted to the railway. However, it does not seem likely that all bus passengers will be handled by rail, at least within the foreseeable future.

Taking the theoretical one-half hour transit load for the Bridge Railway in 1952 and assuming that as many East Bay bus lines as possible deliver their passengers to railway transfer terminals, but that some Key System and all Greyhound lines will continue operation by bus across the Bay the number of passengers, eastbound, during the half hour peak is estimated to be

Lines		No. of persons Bay Bridge Rails
Rail, A,B,C,D,E,F	(100% x 3532)	3532
Bus, G.H.(Berkeley); K,N(East Oakland)	(100% x 3113 x 65%)	2023
Bus, L,J(Richmond)	(0% x 888 x 65%)	None
Bus, R(Hayward)	(50% x 623 x 65%)	202
Bus, O,W(Alameda)	(70% x 906 x 65%)	410
	Total	6,167

This does not include any future expansion and, therefore, the single track plan might well be designed to handle the 1952 load plus a margin of, say 50%, for possible future increase. This would require a carrying capacity of 9,250 persons during the peak 30 minute period. The Rapid Transit Commission will in time have more accurate estimates of future transit patronage. So, figure of 9,250 persons is only a rough approximation of the possible patronage but suitable for the present purpose.

Traffic Capacity of Single Track

The capacity of the Bridge Railway with partial single track is difficult to compute because of the large number of variable factors, such as type of cars, maximum tolerable delay to trains in the off-peak direction, speed of cars on the track, relation of the crest of the peak to the remainder of the peak hour, and the feasibility of accurate scheduling. Nevertheless, an attempt will be made to estimate the capacity in order to get an idea of the practicability of the plan. It will be assumed that the single track operation will serve not more than

the three trunk lines in the East Bay, previously discussed. The theoretical transit load of 9,250 persons in 30 minutes could be carried in 76 two-car units, each seating 122 passengers if all new rolling stock of the general type purchased by the Chicago Transit Authority is obtained. These cars could be made up into 13 twelve-car trains (a twelve-car train of new equipment would correspond to a six unit train of present equipment). New equipment should be so designed as to permit operation of trains up to 24 cars long, corresponding to operation of 12 unit trains with the present equipment. Separate eastbound trains leaving from the San Francisco Terminal simultaneously would be coupled together and operate as a single train over the bridge to 40th and San Pablo, where they would be split into separate trains. It should be practical to operate 12-car trains on 1 minute headways in groups of 3 with 6 minutes between groups, thus allowing a total of 12 trains consisting of 72 two-car units carrying some 8,800 persons to cross the bridge during the peak one-half hour. If traffic should become heavier than this, then a heavier concentration of eastbound trains might be operated at the crest of the evening peak if one scheduled westbound train could be omitted at this time. The foregoing computations contemplate providing seats for all passengers during the peak, although in actual practice most transit systems during

the crest of the peak carry as many standees as seated passengers.

The time table on the following page indicates how 15 trains of up to 24 modern-type cars each could be scheduled across the bridge during the crest of the evening peak.

Theoretical Timetables for 15 Trains Per Half Hour

EASTBOUND

Train No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(Minutes after beginning of peak period)															
Lv SF Term (Multiple Trk)	01	02	03	09	10	11	12	13	14	20	21	22	28	29	30
SF Anchorage (Begin Single Trk)	02	03	04	10	11	12	13	14	15	21	22	23	29	30	31
Ar Y.B.Is. (Passing Trk)	05	06	07	13	14	15	16	17	18	24	25	26	32	33	34
Lv Y.B.Is. (Begin Single Trk)	06	07	08	14	15	16	17	18	19	25	26	27	33	34	35
Ar E.B.Fill (Begin Double Trk)	09	10	11	17	18	19	20	21	22	28	29	30	36	36	38

WESTBOUND

Train No.	1	2	Deadhead	3
Lv E.B.Fill (Begin Single Trk)	55	07	11	22
Ar Y.B.Is. (Passing Trk)	58	05	14	25
Lv Y.B.Is. (Begin Single Trk)	59	07	18	26
Ar SF Anchorage (Begin Double Trk)	02	10	21	29
Ar SF Terminal	04	12	23	31

Note: Each of the above westbound trains consists of two or more trains from the main East Bay trunk lines, assembled or "coupled on fly" in East Bay Yard. One minute headways assumed.

This illustrative timetable has gaps of six minutes between departures of groups of eastbound trains

to allow passage of westbound trains over the bridge. With the present slow equipment the gap would necessarily be around eleven or twelve minutes, which would probably be intolerable. Consequently, operation of the Bridge Railway as a partial single track facility demands faster equipment. With such equipment the elapsed time for any train on single track would be cut substantially so in the event of disruption of schedules, a train waiting to enter single track territory would seldom be delayed more than six minutes.

As noted above, with three main trunk lines in the East Bay--Berkeley, Piedmont and Oakland--evening rush hour trains would leave San Francisco on about one-minute intervals or less for these three destinations. Under these conditions westbound trains would be subject to a delay of up to two minutes on the Island during the evening peak, since the westbound train would be scheduled to arrive at the Island simultaneously with the first of the three eastbound trains and then would wait until the third eastbound train, following not more than two minutes behind the first, has reached the Island passing track.

Problems of Scheduling

Adoption of the partial single track operation would introduce difficult problems of scheduling not now encountered. For instance, at the present time headways, train schedules and length of time required for the round

trip are determined by such factors as the 1) necessity for laying out satisfactory runs for the trainmen, 2) distance of the run, 3) traffic demands of the area served, 4) number of trains assigned to the run, and 5) number of scheduled trains in service. In addition, some leeway must be made for delays incurred by vehicular congestion if the trains operate on city streets. If the East Bay trunk lines are reconstructed on separate rights of way, delays to trains by surface traffic would be eliminated. However, the scheduling of trains at optimum intervals to avoid conflict on single track portions of the crossing is difficult and there is much less flexibility to take care of schedule failures than is the case with double track throughout.

Rolling Stock Requirements

The inability to schedule trains precisely according to the optimum time schedule under the single track plan would probably lengthen the time for the round trip cycle, and this in turn would increase the number of trains in service by about one train on each of the three lines. On this basis the number of new cars previously estimated for continuous service would have to be increased to 32 to provide three additional two-car trains during the off-peak period, not including spares. Although about 23 of the existing units can be modernized to help carry the peak hour load, the transit load might ultimately reach the point at which these

cars would prevent efficient use of new equipment, in which case the old cars would have to be discarded and replaced with new equipment. However, until this happens it will be assumed that 22 of the old units will be used in peak hour service, with the 23rd unit reserved as a spare. On this basis, the total amount of new equipment that is needed is estimated as follows:

Rolling Stock Requirements for Various Volumes of Transit Patronage

1	2	3	4	5	6	7	8	9
			Commuters		New Cars Required			
Commuters - Max. No. in period of 30 Min.	40 Min.	No. Carried in old units (192x22 cars)	Carried in New Cars (Col. 2-3)	Passengers per car at 3*	Spares	Extra Needed Acct Track	Total Single New	Cars
5,000	6,000	2,900	3,100	90	2	6		98
6,000	7,200	"	4,300	70	4	6		80
7,000	8,400	"	5,500	90	4	6		100
8,000	9,600	"	6,700	110	6	8		124
9,000	10,800	"	7,900	130	6	8		134
10,000	12,000	"	9,100	150	8	8		166

Note: Above computations based on 40 minute round trip cycle. It is assumed 10 minute period immediately preceding peak one-half hour has 20 percent of the commuter demand of the latter.

Modification of Terminal

The Bridge Railway Terminal Building as now arranged permits operation of trains not more than three articulated units long--that is, 330 feet. Under the present system of surface operation of trains in the East Bay this length of 330 feet permits trains to stop

* Col. 4/60.5

in the middle of a block without obstructing cross streets. At one time trains as long as six units--660 feet--were operated, but this involved undesirable conflicting movements between commuters getting on and off the trains in the terminal as well as obstruction of East Bay Streets. However, with platform-height loading and with the construction of suitable fences and other barriers, it is believed the terminal could be arranged to accommodate six-unit or twelve-car trains satisfactorily. Operation of trains of this length would be necessary under the single track plan but would not be necessary if the two-track line on the bridge is retained. If the Bridge Railway was extended to new uptown termini in San Francisco, as previously discussed, the loading and unloading of passengers would be fairly evenly distributed at three stations instead of being concentrated on one station and loading and unloading from the same platform area would not cause any particular difficulty.

Lower Deck Vehicular Traffic

To obtain four lanes on the Island, lower deck westbound traffic would have to be routed through a new tunnel on the north side of the present tunnel; eastbound traffic would continue to use the three-lane roadway through the existing tunnel. On the bridge the present lower deck has three 10.33-foot lanes. If one track is removed, a total roadway width between curbs of about 44 feet could be obtained, which would provide four 11-foot

lanes. This roadway would carry mixed traffic--trucks, buses and private automobiles and the maximum number of automobiles carried by the lower deck probably would not exceed 1,500 in each direction during the peak hour. The following tabulation indicates the capacity of the bridge in each direction under two different methods of operation.

Autos - Traffic Capacity - Bridge Operated With Three Lanes in Each Direction on Upper Deck (Vehicles per hour)

Lane Number	4-EB	3-EB	2-EB	1-EB	1-WB	2-WB
Upper Deck	1,400	1,600	1,600	1,600	1,600	1,400
Lower Deck (2 lanes each direction)			1,500 not incl. trks and buses		1,500 not incl. trks and buses	

Total Automobiles. . . . . 6,100 Eastbound 6,100 Westbound

Autos - Traffic Capacity - Bridge Operated with Unbalanced Lane Assignment Upper Deck, Peak Hour (Requires Installation of Lane Assignment Signals and Operation with Reversible Lanes)

Lane Number	4-EB	3-EB	2-EB	1-EB	1-WB	2-WB
Upper Deck	1,400	1,600	1,600	1,600	1,600	1,400
Lower Deck (2 lanes each direction)			1,500 not incl. trks and buses		1,500 not incl. trks and buses	

Total Automobiles. . . . . 7,700 Eastbound 4,500 Westbound

The above may be compared with the estimated capacity with unbalanced lane assignment on the present three-lane lower deck, which is undesirable due to having only one lane for westbound commercial vehicles.

Autos - Traffic Capacity - Bridge Operated with Unbalanced Lane Assignment Lower Deck (Vehicles per hour)

Lane Number	3-EB	2-EB	1-EB	1-WB	2-WB	3-WB
Upper Deck	1,400	1,600	1,600	1,600	1,600	1,400

Lower Deck		
(2 lanes one direction. 1 lane opposite)	(2 lanes) 1,500 not incl. trks and buses	(1 lane) Trks and buses only, no autos

Total Automobiles..6,100 Eastbound 4,600 Westbound

To attain the foregoing estimated traffic volumes it might be necessary to prohibit slow-moving heavy trucks on the lower deck of the bridge during certain hours of the day, especially the rush hours. At the present time it is not possible to predict whether the actual flow of vehicular traffic eastbound as compared with westbound will be such as to permit unbalanced operation of the upper deck. The capacity indicated in the second of the foregoing three tables of 7,700 automobiles in one direction to 4,500 in the opposite is in the ratio of 1.7 to 1.0. As discussed in Part I, the present traffic load of 4,500 to 3,500 indicates a desirable roadway capacity ratio of 1.3 to 1, or in terms of percentages, 55% to 45%. This means that unbalanced operation of the upper deck would be infeasible if the present ratio continues.

Legal Problems

Unlike the other plans discussed in this report, that is, the total abandonment of the Bridge Railway or the continuation of the Bridge Railway as a

double track facility, the single track plan necessitates obtaining additional rights-of-way on the Island from the Federal government to permit construction of a new one-way tunnel for westbound lower deck vehicular traffic. It has been stated in previous reports that this right-of-way cannot be obtained except by Act of Congress, although a revocable permit possibly may be obtained without the necessity of congressional action.

This point is covered in more detail in the Division of Bay Toll Crossings report entitled "Report of Department of Public Works on Additional Toll Crossings of San Francisco Bay", November 1948, Chapter XIII, Page 121. The matter is also discussed in the report entitled "Report on Additional Toll Crossings of the San Francisco Bay as Proposed by Consultants to Assembly Interim Committee" Division of Bay Toll Crossings, October 1949, Chapter XI. A portion of Stage III of the plan described in this latter report corresponds roughly to that contemplated with the four-lane roadway proposal which requires a single parallel tunnel on the Island.

Approximate Cost Estimate -- (based on possible locations and costs of comparable projects only)

(For Rail Improvements)

Rolling Stock	
Modernizing 23 articulated units for use during peak hours	$ 460,000
New cars, 80 required	4,800,000
Centralized Traffic Control	1,000,000
San Francisco Terminal	
Escalators	200,000
Loading platforms, raising of	100,000
Extension of tracks to new terminal	3,000,000
Rail Line Improvements in East Bay	
Loading platforms at Island Army Base	50,000
Improvements on trunk line from end of Bridge Railway on mole to University Avenue in Berkeley	2,500,000
Rapid transit line to downtown Oakland	9,200,000
Piedmont line	(Not included)
Track Changes	100,000
Total	21,410,000

Deduct, Contribution from others for pro-rata share of cost of East Bay lines used for local service as well as for transbay service . . . . . To be determined

Cost Estimate -- continued

(Roadway Improvements to Make Four Lane Lower Deck)

Main Crossing, Lower Deck	
Track Removal	$ 300,000
Redecking w/concrete	1,800,000
Revised roadway lighting	200,000
One-way tunnel and roadway on Island, including new off- and on-ramps and bridge structural alterations	1,400,000
One-way viaduct between San Francisco anchorage and Rincon Hill	500,000
San Francisco Approaches and Ramps	
Construction	500,000
Right of way	1,750,000
East Bay Approaches and Toll Plaza Enlargement (Possibility this item could be deferred)	1,000,000
Electronic Traffic Controller	200,000
Main Crossing, Upper Deck	
Lane assignment signals	900,000
Marginal refuge bays	700,000
Total	9,250,000
Say	$10,000,000

PART IV

ALL-BUS SERVICE

In the event rail service over the Bay Bridge is discontinued, the following alternative plans for utilizing this space for vehicular use have been proposed:

1. Provide a completely unobstructed five or six lane lower deck roadway, which requires removal of all center columns and other obstructions.

2. Provide a two lane and a three lane roadway on the lower deck which does not require removal of the columns, etc.

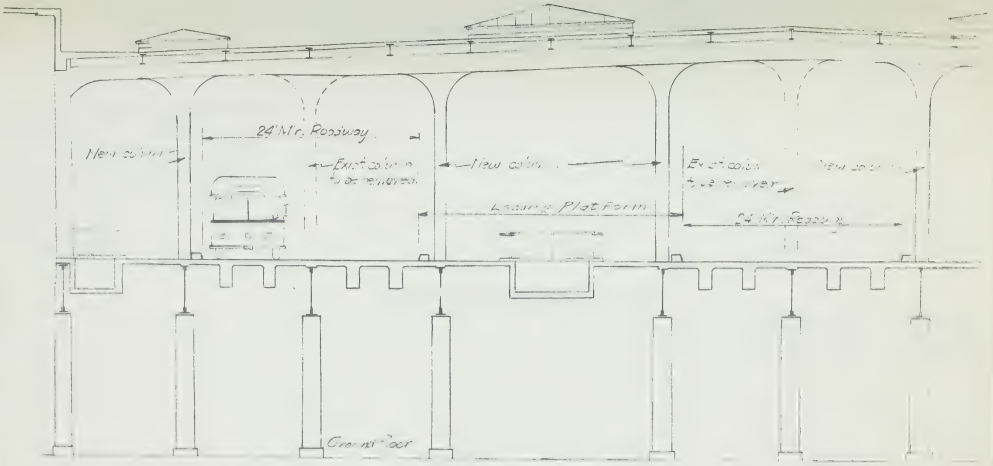
Because of the suggestion made by Coverdale and Colpitts and others, two alternatives should be considered under the second plan. They are: (a) Pave over the rails with a removable deck or possibly some type of surfacing in case it is desired to use the rails at some later date; (b) replace the rails with a permanent concrete pavement.

Plan No. 2 in general is the least costly and requires less time for completion than Plan No. 1. It can be accomplished with less delay and inconvenience to traffic. In this case the dividing wall supporting the upper deck to the Yerba Buena Tunnel and Viaduct will not have to be removed. Also, alterations to the San Francisco approach viaduct would be less difficult and costly. Plan 2 is, of course, the only practical one if it is desired to construct a removable deck over the existing rails.

Discussion of possible methods of handling traffic on the lower deck applies to either (a) or (b) of Plan 2. Plan 1 has the advantage of a choice of six lane operation as on the upper deck or five lane operation (the center lane reversable) with widerlane widths.

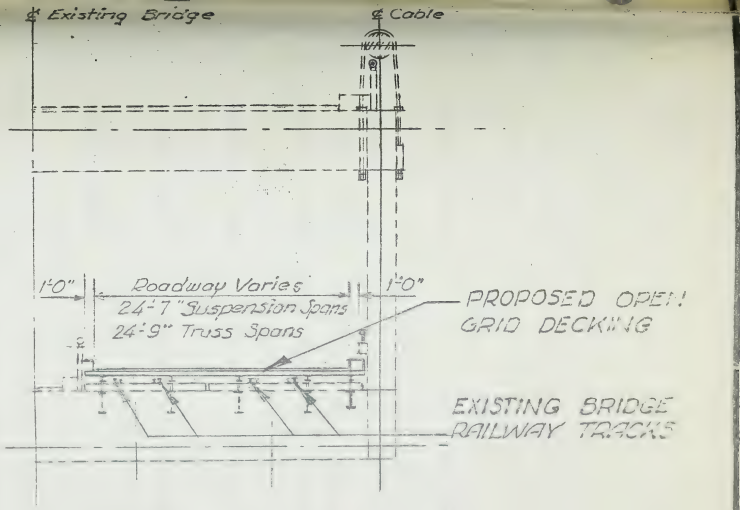
Plan 2(b).

Assuming that the rails are to be temporarily abandoned, the most efficient and least costly plan would then consist of redecking the space occupied by the rails providing two 12-foot lanes which would be separated by the curbed division strip from the present 3-lane truck roadway. The dividing wall and supporting columns for the upper deck in the Yerba Buena tunnel and viaduct and on the San Francisco approach viaduct would not be removed. The lower deck would operate with two lanes eastbound in the space now occupied by the rails and three lanes of mixed traffic westbound in the present three lane roadway. Parts of the railway extending above the running rail, such as signal boxes and the third rail (which would be lifted off the insulators and set down directly on the ties), would be removed and a removable steel floor would be constructed over the rails for use of this space by vehicles. The steel floor would be supported on short steel columns placed between the ties and resting on



ALTERNATE TO BE FURNISHED TENDERER
TO ACCEPT OR REJECT

FIGURE IV-1



Section showing proposed method of providing two lanes of traffic over existing tracks. The plan consists of placing open type steel grid flooring on supports between ties.

TYPICAL SECTION

FIGURE IV-2

SAN FRANCISCO - OAKLAND BAY BRIDGE

SCALE 1"=10'-0" ER No. 54-05-33-25

Dwg by MOM 5-55

the railway stringers. An open grid deck of this length is considered objectionable for high speed automobile traffic. The steel plate deck has been found satisfactory from a traffic standpoint but maintenance of the light-weight surfacing is still to be tested out. The timber ties have frequently been set on fire from from lighted cigarettes, etc., which the use of a solid floor might prevent. However, it would be extremely difficult to put out a fire if one does occur. If only trucks and buses are to use the repaved section, of course, the open floor may be acceptable. The first cost of such removable floor would be little, if any, less than that of replacing the railway with a permanent concrete floor. Its only merit is easier replacement later on with some salvage value.

In the San Francisco terminal, on the approach viaducts, and in the Yerba Buena tunnel the rail facilities can be filled in with gravel, and an asphalt pavement placed over them. It would be necessary to entirely remove and store about 500 feet of track at the San Francisco end of the bridge to permit construction of an on-ramp from the vicinity of Second and Bryant. Planking on the bridge ties would not be strong enough to support temporary surfacing with asphalt.

When and if the Bridge Railway is again required

as a unit of a rail transit system, the steel decking would be removed from the bridge structure, and the gravel and asphaltic surfacing removed from the approach ramps and in the tunnel. The track at the San Francisco end of the bridge would have to be relaid and the third rail lifted back into place. Deterioration of ties, wires, etc., having been remedied, the Railway would be ready to resume operation.

While it is physically possible to so deck over the rails with a removable floor, it should be noted that practically the only saving over Plan 2(a) is in the comparatively small cost of putting the railway back in running order. The time required to construct and interference with bridge traffic would be about the same as for Plan 2(a). It seems apparent that Plan 2(b) has many undesirable features and cannot be justified on purely economic grounds.

Use of Roadway on South Side of Lower Deck for Buses Only

It has been suggested that the decked-over railway be used exclusively as a two-lane, two-direction roadway for buses. In this way, the relatively faster bus traffic would be segregated from the slower trucks, and presumably, be relatively immune to delays from vehicular tie-ups. This proposal would simplify street

connections in San Francisco since it would obviate the need for an expensive on-ramp to the lower deck from the vicinity of Second and Bryant Street. However, traffic statistics indicate the plan has little merit.

For a day selected as typical, July 14, 1952, a total of some 10,700 vehicles used the lower deck in both directions. Of these, about 9,200 were trucks and 1,510 were buses. Since this scheme necessarily assumes conversion of existing Key rail service to buses, it would be necessary to add approximately 1100 to 1300 more buses per day, making a total of 2600 to 2800 buses. Under these conditions each of the two lanes would be used by only 1300 or 1400 buses per day. Compared with the 13,000 or 14,000 vehicles handled per day per lane on the narrower lanes of the upper deck, it is evident this would be a very inefficient use of space on the Bridge. Also, in the event of a bus breakdown, the roadway would be reduced to one lane which might cause a tieup of all bus transportation on the Bridge until the disabled bus could be removed.

Another disadvantage is that in order for all buses to reach these lanes an expensive connection at the east end is necessary to get the westbound buses over the vehicular lanes and to the lower deck roadway

on the south side of the bridge. This cost would offset, in part, the savings in cost of simpler and less expensive connections in San Francisco. It has been suggested that the need for a separation structure at the east end of the mole could be averted by building a two-lane bus roadway through the Key System subway to 40th and San Pablo. However, this requires a circuitous routing for buses that use the Eastshore Freeway to the north to reach Richmond, Albany and Berkeley, as well as those operating south over the freeway to reach Alameda, East Oakland, Hayward, etc. Such a routing will increase operating mileage with no additional revenue.

A separate bus roadway will not permit improvement of the present inadequate lower deck connections to Yerba Buena Island, nor will it eliminate left-turning movements there. It will not conform to the one-way street pattern in San Francisco as well as use of the south roadway for eastbound traffic only. Again the existing ramp connections and bus terminal facilities are suitable only for Key System bus operation; all other buses as well as trucks would use the existing three-lane, lower deck roadway. Hence the expenditure for new facilities would primarily benefit Key System operation. With the steady decline of Key patronage

the bus roadway would be used by fewer and fewer vehicles each year while the need for use of this space by other vehicles would become more pressing. This would cause an unfavorable reaction on the part of the public so that from the standpoint of public relations as well as reduced efficiency a separate bus roadway is undesirable.

PERMANENT ALL-BUS OPERATION

A number of problems incidental to the all-bus operation were studied in detail by the Division of Bay Toll Crossings in 1949, and are described in its report entitled, "Report on Additional Toll Crossings of San Francisco Bay, as Proposed by Consultants to Assembly Interim Committee." Much of the material which follows is based on or taken from this report.

Changes Necessary to Permit All-Bus Operation

Before the recent strike, some 51 two-car train units in service handled about 10.7 million passengers a year. (The remaining units of the 88 total were not in service.) Each train unit can seat 132 passengers, compared with 48 to 51 passengers on modern buses. About 125 new buses would be required to provide seats for these train passengers which added to 135 buses now in transbay service makes a total of 260 buses needed

to transport the present volume of approximately 17,000,000 passengers per year. These additional buses will increase traffic congestion on the lower deck of the bridge from the time the trains are discontinued until the tracks are replaced and two new vehicular lanes made available.

San Francisco Terminal Modifications

Consideration has been given to remodeling the San Francisco terminal for use by buses. At present, train passengers use the Terminal Building located between Fremont and First Streets, south of Mission Street. Bus passengers board buses from city streets. As soon as the trains are discontinued the Terminal Building could be remodeled for buses and the elevated rail ramp between the lower deck of the bridge and the terminal paved so as to get the buses off the city streets.

The present terminal has 6 loading tracks arranged in pairs with passenger loading platforms located between pairs of tracks. The roof is supported by columns set between the tracks. If buses are used in place of trains, a standing lane and a running lane must be available for each platform. The two pairs of tracks give ample space for buses to pass one another, but the existing columns supporting the roof must be removed and replaced by columns set on the passenger

loading platforms, as shown in Figure IV-1. The troughs now occupied by tracks must be paved to platform level and suitable barriers built on the platforms to control passengers.

The capacity of the Bridge Railway terminal, if converted to buses, is dependent upon the length of curb space which can be provided for loading and unloading of passengers. With the modifications mentioned, there would be three roadways, each with available curb loading space on one side, about 800 feet long. This means a total curb loading length of about 2400 feet -- adequate for 48 buses and equivalent to a terminal capacity of at least 21 to 24 million commute trips per year. (For purposes of comparison, the present length of curb occupied by loading and unloading for Key buses on First, Fremont, Natoma and Mission totals about 700 feet.)

This arrangement does not make use of the passenger platform on the south side of the building. If the future passenger loading capacity should prove inadequate, an elevated roadway can be constructed over Natoma Street on the south side of the Terminal, to permit full use of this otherwise unused passenger platform. The present volume of traffic does not warrant construction of this elevated roadway now.

The train platforms in the San Francisco terminal are more than twenty feet above street elevation, and in order to make the service more attractive and speed the flow of commuters through the terminal, escalators should be installed. While the benefits received from escalators cannot be evaluated in dollars they are being used in all modern installations that handle passengers. The new bus terminal of the Port of New York Authority in New York City, reflecting the latest thinking in bus terminal design, is equipped with numerous escalators.

Since the terminal building has three floor levels, two separate sets of escalators would be required, one to carry passengers up from the ground to the mezzanine (ticket) floor, the other from the mezzanine to the track level.

It is assumed that the Terminal will always be used for some transit purpose, and without changes in elevation of either the ground or the mezzanine levels. However, the future height of the loading platforms on the track floor depends upon its ultimate use, for rail or bus. In the event of bus operation, the platforms can remain at their present level, but for a rapid transit railway the platforms should be raised about four feet to car floor level. Therefore, regardless of the type of transit escalators between the ground and mezzanine levels would be permanent and need not wait for a decision

on the ultimate transit facility. But installation of escalators between the mezzanine level and the loading platforms should be deferred unless they can be modified at small cost.

The cost of escalators is roughly estimated to be:

To connect street and mezzanine levels, three escalators,.....$100,000

To connect mezzanine and loading platform levels, three escalators,.....$100,000

Feasibility of Converting Terminal Building as Union Terminal For All East Bay Buses

If all Key System buses are to use the converted terminal building, a question arises as to whether some or all buses operated by Greyhound and other operators will be permitted or required to use the terminal.

The terminal building as constructed includes three units--an east unit, a center unit, and a west unit. The track floor extends over all three units. The center unit, the only one now in use for transit purposes, is that portion of the terminal extending between First and Fremont Streets. It includes a ground floor waiting room and a transverse mezzanine floor concourse. The units east of Fremont and west of First respectively do not have waiting rooms but are provided with transverse mezzanine floor concourses, and with stairways or ramps extending down to the street level and up to the track level.

On the ground floor and basement floor of the east unit about 10,600 square feet of space was intended for stores, etc., but the space is now used for "dead" storage. The easterly portion of the ground floor of the west unit was also intended for the same purpose, but is now used as a garage. In the event the space was needed for terminal facilities, it would be a simple matter to convert the garage or any portion of it into a terminal facility. The unused concourses and spaces used for

garage and storage purposes could be remodeled installing separate ticket and passenger facilities therein to give a substantial increase in passenger handling capacity.

Operation of the Bus Terminal

On Monday, July 13, 1953, the numbers of buses passing through the Bay Bridge Toll Plaza were as follows:

Key Buses	East Bound	A.M.	109
Key Buses	West Bound	A.M.	246
Key Buses	East Bound	P.M.	282
Key Buses	West Bound	P.M.	145
Other Buses	East Bound	A.M.	156
Other Buses	West Bound	A.M.	197
Other Buses	East Bound	P.M.	219
Other Buses	West Bound	P.M.	220

It will be noted that on this particular day there were 782 arrivals and departures of Key buses and 792 arrivals and departures of "other buses". If "other buses" are to use the converted terminal the feasibility of handling them will depend on the capacity of the loading platforms during peak hours. Although the number of "other" eastbound buses using the Bridge during the peak hour is not large (about forty-five) the nature of their operation requires the bus to stay in the terminal for a much longer time than is the case with Key buses. However, it appears the Bridge Railway terminal building if reconstructed for buses can provide San Francisco with an off-street Union bus terminal for most if not all East Bay buses.

Possibility of Future Use of Bridge by Southern Pacific Buses

PUC Decision No. 47161, dated May 13, 1952, ordered the Southern Pacific Company to make studies looking toward the abandonment of its transbay ferry operation and substitution with a transbay bus service. The decision, was appealed by Southern Pacific to the California Supreme Court and to the United States Supreme Court but upheld by both. If read in part as follows:

> "The Commission further finds.....that the Company shall make a study and prepare and submit a plan for an improved and expedited transbay automotive passenger service between San Francisco and its East Bay stations in Oakland and Berkeley, to be operated in conjunction with its railway passenger train service."

The number of transbay passengers involved in this operation is about one million annually, including Western Pacific passengers, all of whom are handled across the Bay by Southern Pacific facilities. It is understood that, at least for the immediate future, only passengers on a limited number of intrastate (not interstate) trains are involved but future developments might change the picture. The franchise on the Oakland Pier expires in 1960, and the present fleet of ferry boats is quite old. It is possible that at some future time all mainline rail passengers will be transported over the bridge by bus or rail. Even so the number of buses or shuttle trains required would be a comparatively insignificant part of the total interurban traffic.

More detailed estimates presented in Appendix C indicate that the additional number of trucks or buses on the bridge in both directions during the evening rush as a consequence of complete discontinuance of ferry service would be about 27.

Bus Loading from City Streets During Construction

During the time when the terminal and elevated loop are being converted, all Key buses would have to load and unload passengers from the streets or other temporary facilities. This use of city streets is undesirable since the bus and vehicular traffic peaks both occur at the same time and will cause a serious increase in present street congestion. Other property, possibly acquired in connection with the freeways, may be available for this purpose.

San Francisco Bus Storage

At the present time 130 buses are stored during the day in San Francisco. Key System estimates the entire abandonment of rail operations would necessitate 115 additional bus departures during the peak hour and 80% or about 90 of these buses would also be stored during the day in order to avoid the operating cost of moving so many empty buses across the bridge twice each day. The total bus storage requirements, therefore, would be 220 buses. The 130 buses have been stored beneath the main approach ramp for the Bay Bridge between Third and Fourth Street, with space for 160 buses, which space was needed for freeway construction. Additional space for storage is a matter of availability of space at the time it is needed.

Private automobiles displaced from the areas to be used for bus parking will need other parking space and it may be found advisable to provide for additional parking beneath the bridge railway viaduct or on land not required for bridge operations. Income or rental from such parking areas would probably amortize the cost of construction and would not affect the toll on vehicles.

San Francisco Approaches

The addition of new roadway on the south side of the lower deck for either Plan 1 or Plan 2 will necessitate the construction of an "on" ramp and connection from Bryant Street to provide one-way access for eastbound traffic. The study made by the Division of Bay Toll Crossings in 1949 concluded that this ramp should start at the intersection of Bryant and Second Streets, but the construction of a ramp connecting with the Embarcadero Viaduct will make it impracticable to do this. It now appears that a more expensive and much more difficult connection will have to be made farther to the west with perhaps some saving in right of way cost. Since the lower deck will have a capacity of about 2,000 vehicles per hour eastbound, ramp connections in San Francisco to match this capacity will be difficult and costly. This is because many of the vehicles are relatively slow moving trucks and most of the traffic will have to pass through one or more sig-

nalized intersections. It would be unwise to spend several million dollars flooring the rail area if its traffic capacity is to be limited by a bottleneck at the San Francisco approach ramps. For this reason the San Francisco approach problem requires special attention supplementing the studies made by the Division of Bay Toll Crossings in 1949.

Briefly, conditions at the San Francisco lower deck approaches would be as follows:

1. Westbound traffic (excepting buses) entering San Francisco would use the existing lower deck off-ramp leading to Harrison and Essex Streets.

2. Buses going into and coming out of the Terminal Building would use the elevated loop. Thus, buses destined for storage would never reach the city streets.

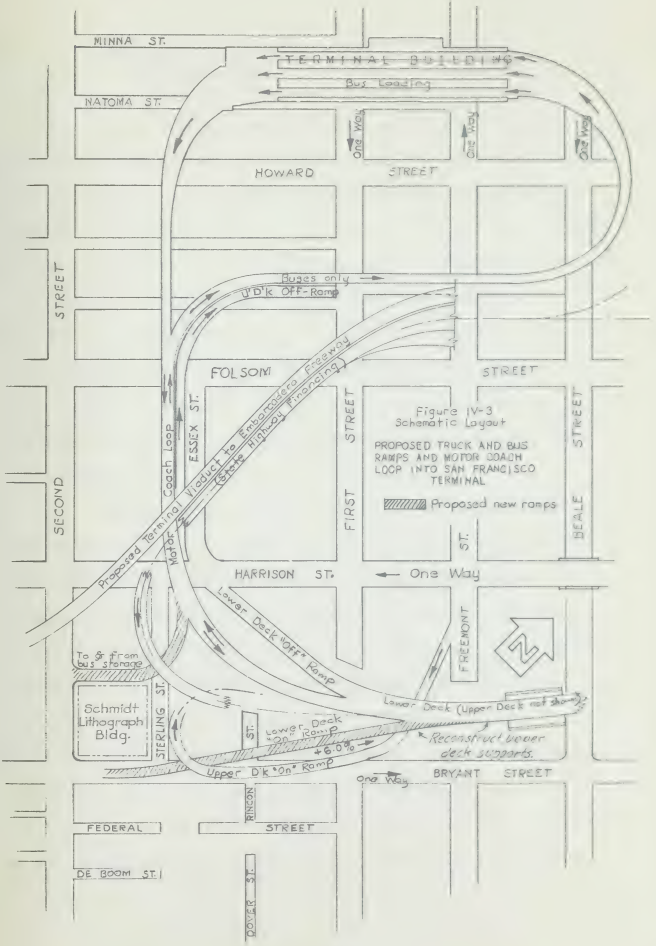
3. In the morning there would be a movement of empty buses from the loop to the bus coach storage area. In the evening there would be a movement in the opposite direction from the storage area to the loop and thence into the terminal to load passengers.

4. Lower deck traffic leaving San Francisco for the East Bay would have to enter via a new on-ramp. There are four likely locations where this ramp could be constructed. These are:

   (a) A diagonal ramp from Bryant Street to a point underneath the upper deck east of Sterling Street.

   (b) A ramp underneath the upper deck from 2nd Street crossing Sterling Street and continuing to the tracks.

   (c) A location alongside and to the west of the above.


MINNA ST.
TERMINAL BUILDING
Bus Loading
NATOMA ST.
One Way
One Way
One Way
HOWARD
STREET
Buses only
U'D'k OFF-Ramp
STREET
FOLSOM
STREET
Figure IV-3
Schematic Layout
PROPOSED TRUCK AND BUS RAMPS AND MOTOR COACH LOOP INTO SAN FRANCISCO TERMINAL
Proposed new ramps
ESSEX ST.
STREET
FIRST
STREET
SECOND
STREET
Proposed Terminal Viaduct to Embarcadero Freeway (Future Highway Financing)
Motor Coach Loop
ST.
BEALE
HARRISON ST.
One Way
Lower Deck "OFF" Ramp
To & From Bus Storage
FREMONT
Lower Deck (Upper Deck not shown)
Schmidt Lithograph Bldg.
STERLING ST.
ST.
Lower Deck "On" Ramp
+6.0%
Reconstruct lower deck supports.
Upper Dk "On" Ramp
One Way
BRYANT
STREET
RINCON
FEDERAL
STREET
DE BOOM ST.
POTRERO ST.

(d) A circular loop beginning at Second and Harrison Street and curving through 180 degrees to meet the railway viaduct.

A direct diagonal ramp from 2nd and Bryant has reasonable grades and conforms to the present one-way street pattern but it will require the removal of a very expensive building. Piers and columns for the Embarcadero connection to the upper deck will now interfere with the location of this ramp as indicated in the Division of Bay Toll Crossing's report. It will now require much more extensive changes in the supports to the upper deck. Its construction seems possible but expensive and difficult as it involves keeping traffic moving on the upper deck.

Ramps immediately underneath the upper deck or alongside it have the advantage of occupying relatively inexpensive right of way, but a diagonal connection to Bryant St. would still be necessary to avoid right angle turns along existing streets. It is necessary to provide adequate turning radius for long trucks off Bryant to the ramp. Clearance for railroad tracks on Second St. prevents carrying the ramp beyond that point. The grade, therefore, would be steeper than on the upper deck.

An additional ramp is necessary in San Francisco to handle buses after they start operating over the bus

loop and reconstructed terminal. The Division of Bay Toll Crossings suggested that:

"buses that have unloaded their passengers in the morning and are to be stored in San Francisco for the day, will return via the loop to just south of Harrison Street. At this point they will turn right to Sterling Street and right again to a new ramp along Stillman Street and under the upper deck of the bridge. They will cross Second Street and enter the storage yards beneath the main bridge approach ramp between Second and Fourth Streets. In the evening these buses will return along the same route to the elevated bus loop just south of Harrison Street. At this point it will be necessary for the empty buses to cross the line of eastbound loaded buses at grade. The intersection is not desirable. To avoid accidents, caution will have to be exercised by all bus drivers. A careful study was made in an effort to avoid this crossing, but no more satisfactory arrangement appears practical. Any other plan involves expensive construction, prohibitive grades, or the taking of large amounts of expensive right of way."

Improvement of Island Lower Deck Connections

One of the more hazardous places on the bridge is the intersection of the lower deck with the Treasure Island approach at the west end of the Yerba Buena tunnel. Vehicles from San Francisco destined to the Island must make a left turn across opposing westbound traffic. Vehicles bound from the East Bay to the Island must swing out wide into the center lane and practically come to a complete stop before making a right hand turn. Work scheduled for construction in 1954 includes a revision of this lower deck connection to permit westbound trucks to turn directly off the bridge without encroaching into the middle lane.

A storage lane for left turning vehicles, that is, those from San Francisco to the Island, would also be desirable, but it cannot be constructed without considerable difficulty. This problem was studied by the Division of Bay Toll Crossings and a detailed layout was prepared for improving the lower deck connection if the rails are to be retained. The plan consisted of widening the lower deck at the east end of the Island, moving numerous columns, moving the rails somewhat to the south, and constructing an adequate off-ramp for westbound vehicles. For eastbound vehicles, a left turn across opposing traffic would still be necessary, but a storage lane was provided for these vehicles. The connection from the lower deck to the Island at the west end of the tunnel would be closed under the Division of Bay Toll Crossings' plan.

However, if the rails are removed or decked over then it will be possible to eliminate the objectionable left turns across opposing streams of traffic. New connections could be constructed at the east end of the tunnel in the vicinity of the firehouse, and the connection at the west end of the tunnel might possibly be closed, as was proposed by Bay Toll Crossings. The work would be coordinated with proposed off-roadway bus loading zones discussed below; thus all off and on movements could be concentrated at one point of control. This work necessitates moving a number of columns and of constructing new approach roadways and ramps on the Island.

Bus Loading Zones on Yerba Buena Island

Under present operating procedures the trains stop at Yerba Buena Island to load and discharge passengers, but Key System buses do not. Any alteration of bridge facilities on Yerba Buena Island requires that permission be obtained from Federal Authorities. It is evident that adequate provision must be made for handling passengers to and from the Island if buses are substituted for the trains.

So far as can be ascertained the Key System has no definite plans for bus service to the Island. Prior to World War II service to the Island was provided by a single 17 passenger bus operating as a shuttle between San Francisco and 38th and Peralta. Trains originally did not stop at the Island. If it proves infeasible to stop through buses at the Island, this shuttle bus service could be restored but larger and more numerous buses would have to be put on the run. In this manner a stop at the Island for through buses might be eliminated, thereby improving the through service and avoiding provision for off-roadway loading zones on the Island. The shuttle bus could drive entirely off the bridge, perhaps to Treasure Island.

Certain aspects of this problem were studied in detail by the Division of Bay Toll Crossings, and a proposed scheme is shown in its October 1949 report.

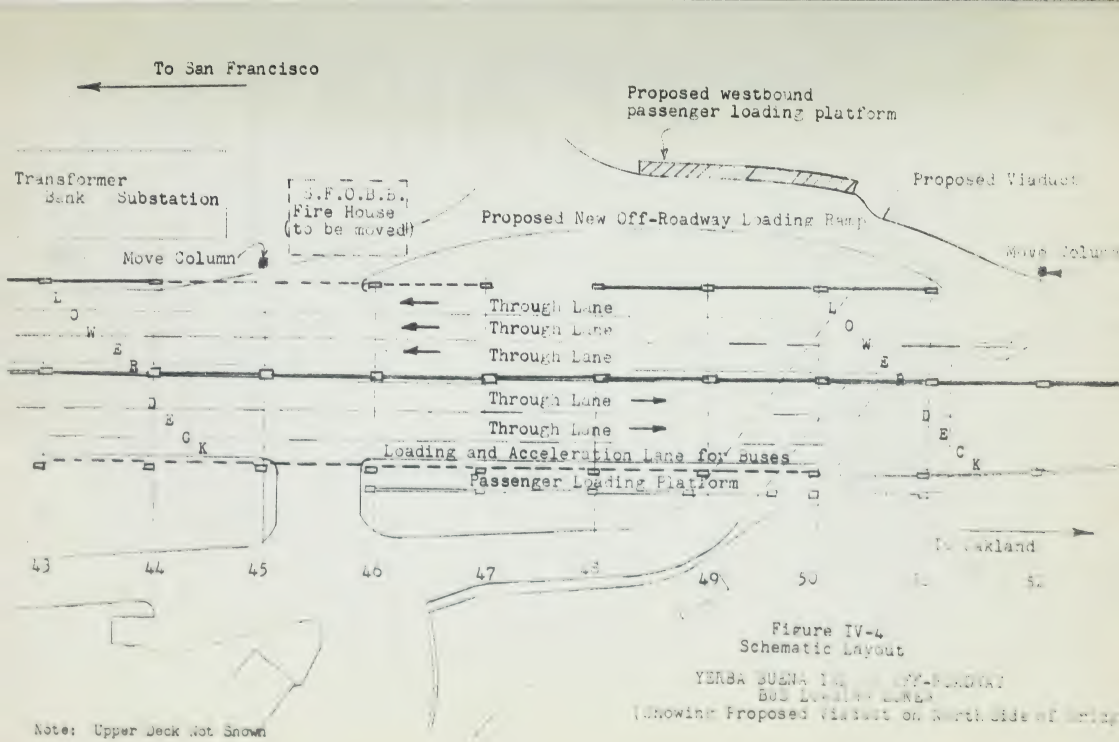


Figure IV-4
Schematic Layout

YERBA BUENA I... OFF-ROADWAY
BUS LOADING RAMPS
(Showing Proposed Viaduct on North Side of Bridge)

The following is quoted from this report:

"Yerba Buena Island buses.....cannot be turned off the bridge to some separate terminal, because such an operation would result in an unacceptable loss of time to through passengers. Therefore, facilities for discharging and loading passengers must be provided as part of the lower deck alteration. These modifications must be adequate to permit the buses to decelerate, stop, and accelerate with the least possible hazard to themselves and to the much larger volume of through traffic. In addition to these arrangements for buses, facilities must be provided for lower deck vehicles to leave and enter the bridge on the Island."

In the Division of Bay Toll Crossings' report it was assumed that the lower deck would carry only two lanes in each direction, and for this scheme adequate space could be made available without major structural alterations for off-roadway loading zones for both westbound and eastbound buses. However, for the scheme now under discussion which is two eastbound lanes over the rails and three westbound lanes on the present vehicular roadway, there is no space on the structure to permit westbound buses to stop. To obtain this space it appears necessary to widen the Yerba Buena Viaduct and remove and relocate one or two of the existing columns supporting the upper deck to permit access to the loading zone.

Timing and Sequence of Construction on Island

Timing of the work of reconstruction is of vital importance in preventing disruption of transit service. How the work can be programmed is covered in the following quotation from the Division of Bay Toll Crossings' 1949 Report:

"While the trains are still running, sections of the collision wall between the tracks and the lower deck roadway can be removed and east of the tunnel portal a temporary roadway can be built across the tracks to the south wall. At the same time, bus passenger loading platforms can be constructed on both sides of the roadway. When train operation ceases, a few hours work will make it possible for the eastbound buses stopping on the Island to swing to the right across the tracks to the new loading platform.

"While the tracks are being removed and the south side of the lower deck of the bridge is being reconstructed, the terminal facilities on Yerba Buena Island will be completed. This will give a loading platform for bus passengers on each side, with a separate lane for decelerating, stopping, and accelerating. This same lane must be used by lower deck vehicles entering or leaving the Island. For the latter operation, a relocation of upper deck columns will give a longer and better turning radius than is now available.

"The facilities for handling these various movements of traffic on the lower deck at the Island are considerably less than desirable. It is unavoidable that substandard facilities will exist, and careful controls and policing will be required at all times."

East Bay Approaches and Toll Plaza

At the East end of the bridge structure some structural alteration will be necessary. The present two-lane, westbound on-ramp on the north side of the bridge should be widened to three lanes. This widening will apparently necessitate moving at least two columns and making certain structural alterations in the steel work supporting the upper deck. For eastbound vehicles the space now occupied by the rails can be utilized with no structural alterations.

Additional toll plaza capacity is to be constructed from the 1951 "Series A" bond issue. This will increase

the number of toll lanes from 20 to 30. Since freeways are loaded to capacity almost as soon as they are opened to traffic, additional toll plaza facilities might be required following the opening of additional lanes to highway travel. Eight or more additional toll booths, four on the north and four on the south sides, may be necessary at some future date. On the north toll plaza there is adequate room for these additional booths and on the south it will be possible to use the present railway yard which will be vacated if train service is abandoned.

Upper Deck Lane Assignment Signals

The plans for reconstruction of the bridge contemplate the possibility of unbalanced use of the upper deck during the evening peak hours with four lanes eastbound and two lanes westbound. This would necessitate installation of "lane assignment signals" to indicate which lanes are to be used. Such signals would be installed on overhead signal bridges, one for each lane. The signal bridges would be spaced about 800 feet apart. Traffic lights on the upper deck have also been advocated to permit blocking one or two central lanes when traffic is light. These neutral lanes act as a dividing strip and should reduce head-on collisions which are of frequent occurrence during late hours. Other ways in which such lights might be useful are at the approach lanes to Yerba

Buena and Treasure Islands to reduce the conflict between through traffic and vehicles turning to and from the Island; in the handling of parked maintenance vehicles, wrecks, or stalls; and to keep eastbound Fifth Street ramp traffic clear of the Fremont Street on-ramp.

Previous preliminary studies for an upper deck signal system have estimated its cost to be about $900,000.

Marginal Refuge Bays

If it becomes desirable to operate the six-lane upper deck, four lanes in one direction and two lanes in the other, by installing lane-assignment signals, the problem of stalled vehicles will become more serious than it is with the present three lanes in one direction. A stall in the curb lane would reduce the two-lane, one-direction vehicular capacity more than 50%. For this reason it is important to make some provision wherever possible to get stalled cars off the roadway.

Refuge bays have been advocated for this purpose. A report dated January 13, 1951, entitled, "Construction Recommendations of Citizens' Committee for Safety on San Francisco-Oakland Bay Bridge", prepared by the engineering staff of the Bay Bridge, contains the best available analysis of the feasibility and merits of these bays. The background of this report is as follows:

On Sunday, September 25, 1949, six people were killed and eleven injured in two head-on collisions on

the upper deck of the bridge. As a consequence of the public reaction to these accidents, Governor Warren appointed a Citizens' Committee for Safety to study the problem of traffic accidents on the bridge. The committee, consisting of ten prominent citizens of the Bay Area, employed an engineering consultant, Mr. George W. Barton, of Evanston, Illinois. On April 10, 1950, the Committee submitted its report which made twelve recommendations for improvement of the accident situation, either for immediate accomplishment or as a matter requiring further exploration. Six of the recommendations dealt with enforcement, two with maintenance procedures, and four with additional construction. Among the construction recommendations were, 1) traffic lane control lighting system for the upper deck, 2) traffic lane control lighting system for the lower deck, and 3) construction of marginal refuge bays.

Marginal refuge bays, the probable number of decreased accidents resulting therefrom, and the resulting increased traffic capacity were studied by the Bay Bridge engineering staff.

In commenting on traffic capacity, the Bay Bridge staff quoted from a previous report, as follows:

"Since the curb lane is the one generally occupied by maintenance vehicles in the off-peak hours and is also the lane in which non-wrecked vehicles generally stall, the disinclination of a driver to use this lane is clearly related to the discomfort he experiences. Only under conditions of maximum traffic density can he be induced to use the curb lane to anywhere near the same degree as the middle and center lanes.

"Maximum capacity on the bridge is, of course, only necessary during the peak hours. However, if the measure of economic value of a traffic lane is the volume it will carry under peak load conditions, it is apparent that the curb lanes of the bridge are of less value than the middle and center lanes. To the extent that the construction of refuges would induce greater use of the curb lanes, it would justify a corresponding investment of funds."

During the peak hours traffic in the middle and center lanes average approximately 1500 vehicles per hour, while traffic in the curb lanes is from 200 to 400 vehicles per hour less. Thus, if construction of refuge bays would result in 100% efficient use of the curb lanes, then the traffic capacity of the bridge in one direction would be increased by 200 to 400 vehicles during the peak hour. However, it was estimated that only about 1/5 of the stalls or other causes of blockage of the curb lane could be eliminated through use of the refuge bays. The increase in traffic capacity based on the estimated cost of providing one additional traffic lane on a new bay crossing, indicated that the proposed refuge bays would have a value roughly estimated at $700,000 or more in terms of increased traffic capacity. It was also apparent that there would be additional benefits in accident reduction having an estimated present worth of between $330,000 and $1,000,000. The estimated construction cost for the marginal refuge bays was slightly less than $700,000 at 1950 prices.

Although the estimated value of prospective benefits outweighed the estimated cost, uncertainty as to the future of Bay crossing facilities deferred further consideration of refuge bays. It appears in light of the assumed conditions that refuge bays may be warranted, particularly in the case of signalizing the upper deck to allow only two lanes of traffic in the off-peak direction at certain times of the day.

Construction Program

Maintaining continuously adequate mass transportation during the conversion period from rail to bus will require careful planning and scheduling. The following steps can be taken before all train service is discontinued:

1. Order new buses (which cannot be delivered for a considerable time). It is doubtful if Key System would be willing to purchase the required additional buses.
2. Obtain and prepare additional bus storage in San Francisco.
3. Prepare the temporary eastbound and permanent westbound bus terminal facilities on Yerba Buena Island, as previously described.
4. Initiate work on the lower deck ramp connections in San Francisco.
5. Since all of the tracks are not now needed for train operation, a considerable amount of work

could be done on the terminal prior to discontinuing train service. It could include moving columns and placing the paving for at least one and possibly two roadways. Paving one lane on the approach viaduct could also be completed for several hundred feet in each direction without interfering with train traffic.

6. Contracts should be let for fabrication and delivery of deck members well in advance of removing the tracks.

7. On the bridge structure it may be possible to operate portions of the Bridge Railway as a single track while construction operations are in progress which would permit some track removal and repaving before trains are entirely discontinued.

The above measures will permit the interval of time between the last train into the terminal and first bus into the loop to be reduced to a minimum. As soon as the switchover from trains to buses is made, the remaining alterations in the San Francisco rail loop and terminal should be completed as quickly as possible so buses can be taken off the streets. Redecking the rail area will, of course, proceed as rapidly as possible to relieve the added congestion which the increased bus traffic will create.

Cost Estimates

These preliminary estimates for conversion from rail to bus will vary with the various alternative plans which have been discussed. They can only indicate the general magnitude of the operations listed.

San Francisco Approaches & loop revisions Construction	$1,000,000
Right of Way	1,750,000
Terminal Modifications and Modernization. Including moving columns, escalators, etc.	1,050,000
Yerba Buena Island Work Bus Loading zones and off and on ramps	470,000
East Bay approaches and toll plaza enlargement	1,000,000
Redecking of bridge	
Steel decking on bridge, railing, pavement on Island	3,630,000
Pavement on viaducts	100,000
Revise lighting on lower deck	300,000
Upper deck lane assignment signals	900,000
Upper deck marginal refuge bays	700,000
SF-Provision for substitute parking space, lost due to additional bus storage requirements	250,000
Total	$11,150,000
New Buses required, to be financed by others	3,000,000
Contingencies 10%	1,100,000
Grand Total	$15,250,000

Financing

Under the California Toll Bridge Authority Act and the currently applicable outstanding bond resolution, any capital expenditure required to obtain rights of way and to redeck the Railway for use by vehicles would necessarily have to be financed largely from the proceeds of the sale of revenue bonds. The present outstanding authorization for a total issue of $30 million, of which the Series A ($21 million) and the Series D ($3 million) have been issued, is inadequate to permit financing the proposed redecking. Therefore, bonds issued for this purpose must be included under a new authorization.

Cost of Temporary Roadway

The cost of the removable redecking with the open grid or solid steel plate flooring, together with necessary revisions to the Terminal Building, new ramps, lane assignment lights, marginal refuge bays, right-of-way, etc., will be on the order of $12 million, possibly more, not including new buses or operating equipment. If at the end of the interim period, assumed at not less than five years and probably not more than fifteen years, it is decided to restore the rails for rapid transit use, another $1 million or so would be required to remove the decking and to make the Bridge Railway again usable.

Restoration of the tracks would mean that a large portion of this $13 million expenditure, although

not all, would have to be written off. However, the upper deck lane assignment lights and marginal refuge bays could continue in service, as would any off-roadway bus facilities on the Island. The steel decking removed would have some salvage value.

A question then arises, to what extent will additional vehicular revenues resulting from the increased traffic capacity offset a loss of, say, $8 million.

Possible Traffic Capacity

If two lanes of roadway are provided on the lower deck it could be operated as follows:

> Roadway in space now occupied by rails: Two lanes of trucks and buses eastbound. (No passenger cars advisable in case of open grid decking.)
>
> Present lower deck roadway: Three lanes westbound. Trucks and buses only, except during rush hours when passenger automobiles could be admitted.

By diversion of westbound private automobiles to the lower deck during the evening peak, the westbound vehicular load on the upper deck could be materially decreased which, as stated, may make it possible to use one of the present upper deck westbound lanes for eastbound traffic. Thus, an additional eastbound lane would be usable on the upper deck during the evening peak hours. In this case the eastbound traffic capacity would be increased approximately 1600 vehicles per hour, giving a total traffic capacity of 6200 vehicles in the peak

hour eastbound as compared with approximately 4600 with the present arrangement - an increase of 35%. This is a reasonable figure to use for estimating although other methods of operation may be found practicable that will develop still greater capacity.

If rail service is discontinued and bus service substitute, the capacity of the bridge roadway for buses should be about 10,000 seats in the peak hour, outbound from San Francisco. These 10,000 passengers can be handled in 210 buses of 48 seats each and the average time between buses should be about 1/5 of a minute at the crest of the peak. Assuming average speeds on the Bay Bridge of 30 MPH, these buses, even if restricted to only one lane, would be spaced about 500' apart at the crest of the peak. These buses, with the diversion of private vehicles to the lower deck and the expected growth of ~~traffic~~, will in time result in congestion as ~~acute~~ as that on the upper deck. During occasional traffic tie-ups both east and westbound buses can become jammed on the bridge, and if such conditions become prevalent patronage will drop and the cost of service will increase, (it costs about as much per hour for a bus stalled in traffic as it does for one moving on schedule). Thus, although bus service may be an acceptable temporary solution, the growth of traffic on the bridge will cause a breakdown of bus operations sooner or later.

Profit or Loss on Temporary Roadway

It is reasonable to assume that traffic on the Bay Bridge could increase at the rate of about 4% per year if existing capacity limitations were removed. The estimated 35% increase which seems possible on an hourly basis will not likely apply to an entire day; the additional lanes will do little or nothing to promote an increase in traffic during the off-peak hours. However, with the existing congestion, the prospect of appreciable increase in traffic is remote. The increase in revenue as made possible by a temporary deck (but which is not possible under present conditions) may be estimated as follows:

Year of Operation	Gross Increase in Revenue	Less Interest & Toll (3%) Collection	Net Increase in Revenue	Cumulative Increase
1	$400,000	$400,000	---	---
2	800,000	430,000	$370,000	$370,000
3	1,200,000	460,000	740,000	1,110,000
4	1,600,000	490,000	1,110,000	2,220,000
5	2,000,000	520,000	1,480,000	3,700,000
Increase in traffic assumed not possible past this point				
6	2,000,000	520,000	1,480,000	5,180,000
7	2,000,000	520,000	1,480,000	6,666,000
8	2,000,000	520,000	1,480,000	8,140,000

From the above it seems possible the net cost of the facilities to be retired could be recovered through increased toll revenues if the temporary installation

remains in place for about eight years. Either a temporary or a permanent floor as outlined will have also certain immediate advantages which are:

1. Saving of time to transbay motorists due to lessened bridge congestion.

2. Increased safety due to decreased congestion, and possibility of operating the upper deck with unused "neutral" lanes during off-peak hours.

3. Improved connections at the Island for lower deck traffic, and elimination of dangerous left-hand turns across traffic.

4. Improved traffic conditions in San Francisco, due to lower deck tying in with present one-way street system.

5. Improved traffic conditions in San Francisco in vicinity of Bridge Railway terminal, due to all Key buses loading from off-street platforms of terminal and using elevated loop for access to terminal instead of using city streets.

6. Possibility of future use of terminal for other East Bay bus lines in addition to Key buses only.

7. Elimination of all rail transit operations from East Bay streets.

However, the ultimate capacity of bus operation is less than is possible with a railway and the above advantages of time saving and safety will decrease as traffic increases.

Legal Problems

Federal laws and requirements pertaining to alterations in the bridge and changes in operation of mass transit are thoroughly covered in the "Report on

Additional Toll Crossings of San Francisco Bay, as Proposed by Consultants to Assembly Interim Committee," Division of Bay Toll Crossings, October 1949; Chap. XI. It states on pages XI-8 and 9 as follows:

"It will also be necessary to obtain the consent of the Secretaries of Army, Navy and Commerce to the substitution of buses for rails. This follows from a provision in the joint permit which granted the State a right-of-way across Yerba Buena Island, providing that the State should

> 'without expense to the United States and subject to its approval, provide, on the Island for convenience of interurban passengers desiring to visit the Island, a suitable situation within the limits of said right-of-way, or in such other location adjacent thereto as may be designated by the United States.'

"For a period of time after the interurban trains were operated on the bridge, no train service was rendered to Yerba Buena Island. Traffic was handled by bus. However, on August 19, 1942, the Navy exercised its right under the permit and, in accordance with the clause quoted above, requested that interurban trains stop on the Island. The State thereupon altered facilities, and interurban train service has since been provided.

"It therefore appears that if train service on the bridge is abandoned, alternate service by bus satisfactory to the United States must be provided, and an agreement to this substitution obtained from the Federal officers granting the original permit."

The Federal law relating to bridges over navigable waters requires approval of the plans and specifications by the Secretary of Army and Chief of Engineers, and makes it unlawful to deviate from such plans after such approval (Act of March 23, 1906, Chapter 1130, Section 1, 34 Stat. 84, Title 33, Section 491, U.S.C.A.). It might, therefore, be necessary to obtain such approval for any major alterations, such as redecking of the space now occupied by the rails.

The Joint Permit of August 20, 1932, which was signed by the Secretaries of War, Navy and Commerce and granted the State the right to cross Yerba Buena Island, requires that written authority must be obtained "for any material change" in the construction of the portion of the bridge across the Island. This may require such permission for the "changes" necessary to convert the Bridge Railway to a vehicular roadway.

Under the terms of an agreement dated March 6, 1936, Key System is obligated and agrees to operate the Bridge Railway, to maintain the rolling stock belonging to the Authority, and to do certain other things. This can be terminated by Key System in 1958 or as soon as the bond issue for constructing the bridge is amortized. It can be argued that the original bond issue was meant and that the cost has been amortized.

APPENDIX A

PREVIOUS SHUTTLE STUDIES

Weeks' 1941 Report to California Toll Bridge Authority

The crisis resulting in 1941 with the withdrawal of Interurban Electric Railway Company from all transit operations raised a serious question at that time as to whether the Bridge Railway service should be continued. To gather facts on the situation the Department of Public Works was authorized by the California Toll Bridge Authority to employ Mr. H. G. Weeks, Consulting Transportation Engineer, to prepare a report. On November 3, 1941, Mr. Weeks submitted a detailed study of the then existing transit situation, which included an evaluation of the comparative merits of various alternative plans of continuation of the trans-bay transit operation. The plans and studies were as follows:

Plan 1 - Restoration of service of Interurban Electric Railway

Plan 2 - Combination transbay rail and bus service on present (1941) Key System routes

Plan 3 - Transbay through rail service

Plan 4 - Transbay through bus service

Plan 5 - Transbay rail shuttle service

Among Mr. Weeks' findings which are still pertinent are the following:

> "Financially successful transportation of transbay passengers is fundamentally difficult.....commutation fares make a poor load factor - and a large investment in equipment only in use some four hours on week days, and less in the other third of the year. Lower bridge tolls would decrease the possibilities of net earnings, as will increasing maintenance costs of the Bridge Railway Facilities.
>
> "There is no chance to measureably increase present speeds of present train travel, even with new cars, as too much operation is on city streets and on grades."

Plan 5 of Mr. Weeks consisted of a detailed financial analysis and preliminary terminal layout of the shuttle scheme.

The general conclusions reached by Mr. Weeks appear to remain applicable to the present situation, even though the

location for the East Bay transfer Terminal must be shifted from the site alongside the Toll Plaza contemplated in his report.

The following quotations are taken from Mr. Week's report:

"It must be clear that no transbay shuttle service can be installed which will directly serve, i.e., without transfer from connecting service, any great number of transbay passengers. They are too widely spread.

"Because it is not necessary for the passengers at the terminal to segregate themselves as to their respective routes the service can be rendered more economically than when such segregation is required. This arises from the fact that, if a trip averages 170 passengers, it is necessary to operate two cars or 260 seats, whereas in this shuttle operation the accumulation of these extra seats may be reduced.

"Seven-car trains are proposed at the peak times and the frequency of such trains is 1 every 3 minutes from 4:55 to 5:12 PM and arriving at San Francisco, from 7:23 to 7:55 AM. These 7-car trains seat 910 passengers. At other times of day the service is less frequent; during the mid-day every 7-1/2 minutes and early night every 10 minutes, trains consisting of fewer cars. This more frequent service, including the connecting bus lines, should attract more passengers, which, however, has been considered in estimating the loss of traffic due to the unpopular transfer.

"Aside from financial considerations, such a shuttle service, with its accompanying transfer and loss of time, would be extremely unpopular with the travelling public and, in fact, the promulgation of such a plan, in my opinion, would arouse such a storm of public protest that it would not be possible to go through with it.

"Such a shuttle service was suggested in 1933, when the Department of Public Works gave consideration to it. At that time transbay passengers had for many years been transferred across the Bay in ferry boats and they were accustomed to unavoidable and understandable loss of time in transit arising from the change from boat to train. Before the bridge was built and rail service installed upon it, it would have been much easier to install shuttle service than it is at present.

"Under public operation the increase in the total fare is large and seems unavoidable. It would make the [shuttle] plan impractical."

Bartholomew Report to Oakland Planning Commission

The 1947 Oakland Master Plan, prepared by Harland Bartholomew & Associates, City Planners, recommended converting all then existing transbay bus lines, and the B, C, and E rail lines, to a shuttle operation. Because of the large number of riders on the A and F rail lines, these lines were to continue as then operated. This proposal, contained in a pamphlet entitled "Transit Facilities and Mass Transportation in the Oakland Metropolitan Area, A Part of the Master Plan", was recommended because:

"1. The present rail facilities on the bridge are not used to near capacity. Only some 13,500 persons are carried one-way over the bridge during the peak hour whereas approximately twice this number could be handled by train operation.

2. There is considerable congestion on the lower deck which is used by buses. Hazards result from the intermingling of buses and heavy trucks, and from the use of three lanes for two-way movement.

3. The loading and unloading facility for buses at the San Francisco terminal is not now satisfactory and is difficult to improve."

It is understood this portion of the Bartholomew Report resulted in considerable controversy and opposition, especially from outlying districts whose residents feared that their public transit service across the Bay would be impaired, and as a result the Oakland City Council withheld definite approval of this part of the report.

APPENDIX A

DeLeuw Cather Report to San Francisco Planning Commission

The following discussion of a proposed shuttle service appeared in the 1948 report (entitled, Transportation Plan for San Francisco) to the San Francisco City Planning Commission by DeLeuw Cather and Company, Consulting Engineers, and Ladislas Segoe and Associates, Consulting City Planners:

"The present transbay rail operation has many shortcomings, however, which should be corrected. The infrequent service is a distinct element of inconvenience. The operation of long trains over public streets in the East Bay cities has obvious disadvantages. The desirability of modifying this operation so as to provide for a frequent, high-speed rail service between a conveniently located bus-rail transfer terminal on the Oakland side to the existing San Francisco terminal is evident from every viewpoint.

"The widespread distribution of population in the East Bay cities can be best served by feeder bus lines operated over a well distributed pattern to a central location at the east approach of the Bay Bridge. These lines could be operated as express bus routes when and as the projected freeways are built. A modern, efficient transfer terminal can be constructed which would provide a cross-platform transfer from bus to train at no more inconvenience or loss of time than is involved in transferring from the local to express trains in the New York subways. Passengers would transfer from feeder buses to waiting trains, which, if operated on a 90-second headway as here recommended, would involve an average wait of only 45 seconds. The trains now operated on headways of 10 minutes, 20 minutes or more in the East Bay could be replaced with local or express buses operated at frequencies of two or three minutes, or even less.

"The seven mile trip from the east bridge approach to the Bay Bridge Terminal in San Francisco should be made in new modern, light-weight, high-speed transit equipment with the operating characteristics of the modern PCC street cars, and similar generally to the rapid transit cars recently purchased by the Chicago Transit Authority. The travel time on such trains, with necessary revisions to the existing signal system, would be reduced to approximately 10 minutes.

"Traffic conditions on the streets of Oakland and Berkeley will be much improved through the elimination of the existing unwieldly train service and the substitution of curb loading buses. Eventually, many of these buses will disappear from the local street system and will operate at higher speeds over the projected freeways.

"There will be a similar improvement in San Francisco through the elimination of the present transbay bus service terminating on the public streets, roadways and sidewalks in the vicinity of the

Bay Bridge Terminal. Passengers would benefit through provision of protected and covered stations as compared with standing in queues on sidewalks, as at present, while waiting an opportunity to board buses on one of the seven existing transbay bus lines.

"There would be an advantage to the operators, and ultimately to the passengers, through reductions in operating expenses. The ultimate substitution of high-speed express bus service for the present train service on the streets of the East Bay cities would effect a marked reduction in operating expenses. Trunk line train operation at high speed as proposed, with new modern cars and signals, with no delays on the Oakland side for taking off or adding cars, would also accomplish appreciable decreases in costs. These economies would be directly reflected in the operating results of the Key System, and eventually would be passed on to the car riders.

"Improved distribution of transbay passengers will be provided on the San Francisco side through the operation of cars in the proposed Market Street subway, providing delivery on Market Street by first class rail service operated at high frequencies. Convenient transfer facilities for passengers from transbay trains to subway cars are planned. Ultimately transbay passengers can transfer to the trolley buses or gas buses operated in the proposed Post Street subway by a walkway directly west of the existing Key System terminal connecting to the off-street terminal proposed on the east side of Second Street."

APPENDIX A

Key System Shuttle Studies

In recent years Key System has had about 31 to 37 articulated units idle at all times, due to the fact that the number of rail cars available exceeds current needs. Naturally, if more of this equipment could be used to help carry some passengers now handled by buses, at least during the peak hours, it would obviate the necessity on the part of Key System of financing the purchase of new buses, and Key System should logically realize economies in taxation, depreciation, storage, etc. For this reason the engineering staff of Key System has studied from 20 to 30 different schemes for shuttle service. However, due to difficulties of financing these shuttle plans, at least those which would have operated past 40th and San Pablo, contemplated trains operating along city streets. No studies involving East Bay lines at separated grades were made.

In connection with the various shuttle plans terminating at 40th and San Pablo, Key System found that a four-track stub-terminal, with roadways underneath for buses, was the most practical.

At the time the end of the "A" rail line was abandoned, serious consideration was given by Key to the possibility of constructing a shuttle terminal near the Twelfth Street Dam. However, Key System states the adopted plan, which involved a through-bus operation ("K" Line), appeared to be more satisfactory, and was chosen for that reason.

Another plan studied at one time contemplated trains operating along San Pablo Avenue to a terminal in downtown Oakland in the vicinity of the City Plaza. From this point feeder buses would have served the outlying areas, and there would have been no separate "A" or "B" lines extending into residential areas.

Key System feels that the most favorable location for a shuttle terminal, if one is to be built, is on the Mole, alongside or in the vicinity of the Toll Plaza.

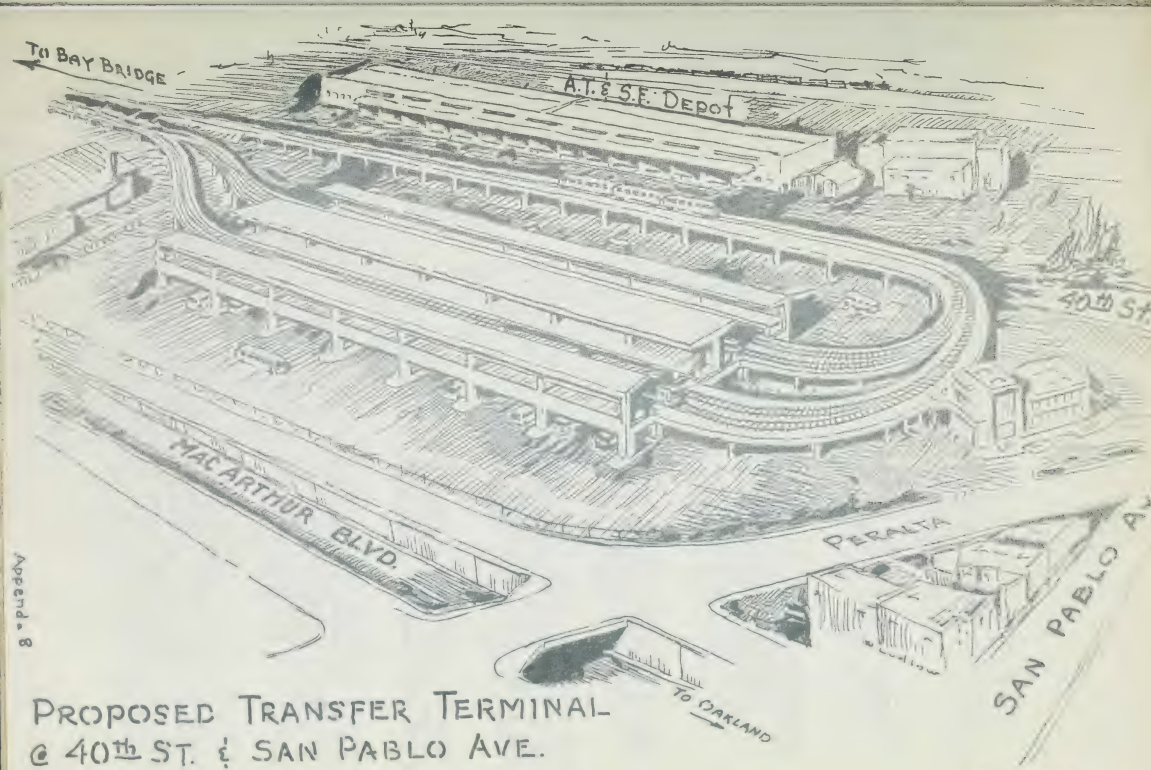
In all of its shuttle studies, Key System found that there were two main problems, namely: 1) the overlap in number of men and amount of equipment required to furnish the overall transportation service, since a through operation is more economical than a transfer operation requiring a duplication of labor and equipment, and 2) providing adequate space, preferably under shelters, where transferring patrons can wait.

In summary, Key System's studies have consistently indicated that the rail shuttle is infeasible and impractical, at least insofar as their operations are concerned.

California Railroad Commission Report Dated August 28, 1946

In a report entitled "Report On Service, Operations and Track of Key System," Application No. 27595, which was prepared by Mr. Ward Hall and submitted to the California Railroad Commission (now Public Utilities Commission), dated August 28, 1946, the following recommendation among others was made.

> "The Company should give serious consideration to the construction of a bus-rail transfer terminal in the vicinity of the San Pablo Avenue and 40th Street in order to relieve the congestion and reduce the hazard on the lower vehicular deck of the bridge."



Appendix 8

PROPOSED TRANSFER TERMINAL @ 40th ST. & SAN PABLO AVE.

Based on Key System Studies

April 1959

APPENDIX B

RESOLUTION WITH RESPECT TO THE CONTINUANCE OF OPERATION OF THE BRIDGE RAILWAY OF THE SAN FRANCISCO-OAKLAND BAY BRIDGE

WHEREAS, Key System, operator of the bridge railway of the San Francisco-Oakland Bay Bridge, has applied to the Public Utilities Commission for permission to abandon its A and B rail lines operating over said Bridge; and

WHEREAS, pursuant to previous action of this Authority, the Department of Public Works, in addition to the studies of its own engineers, has employed the firm of Coverdale & Colpitts, Consulting Engineers of New York City, to make an independent study of the entire operation of the bridge railway and related current problems of interurban traffic across said Bridge; and

WHEREAS, said consulting engineers have presented their report respecting the bridge railway of the San Francisco-Oakland Bay Bridge, dated May 15, 1953, in the conclusions of which the engineers of the Department generally concur; and

WHEREAS, it appears from said report that the abandonment of said A and B lines would require additional buses which would result in a further congestion of traffic on the lower deck of said Bridge during peak hours and would practically exhaust the capacity of, and the opportunity for, future traffic growth on the lower level of said Bridge; and

WHEREAS, the Bay Area Rapid Transit Commission proposes to undertake a comprehensive survey of the need for a mass rapid transit for the entire San Francisco Bay Area and has funds available for such purpose; and

WHEREAS, this Authority concurs in the opinions expressed to it to the effect that said bridge railway is adaptable to and might have an important function in any rapid transit system that may be developed for the Bay Area, and that it should be held intact pending further progress in the development of a policy as to mass rapid transit in said Bay Area; now, therefore

BE IT RESOLVED by the California Toll Bridge Authority that it appear through counsel in said proceeding before the Public Utilities Commission, Application No. 33920, in opposition to the granting at this time of permission to Key System to abandon its A and B rail lines and inaugurate motor coach service in lieu thereof, and that there be filed with said Commission a copy of the report of Coverdale & Colpitts and of this Resolution; and

BE IT FURTHER RESOLVED, that the Department of Public Works be and is hereby requested to continue its present studies and to report to the Authority at the earliest possible date its recommendations with respect to any alterations or improvements of said Bridge, or of said Bridge railway, terminal building, and approaches, which will be required in the event of the discontinuance of existing Key System rail operations and the substitution of a bus service in lieu thereof, together with estimates of costs, time required, legal problems involved, and possible methods of financing; and

BE IT FURTHER RESOLVED, that the Department of Public Works be requested to consider the question of whether a shuttle service across said Bay between the cities of San Francisco and Oakland over said bridge railway is practicable, and to report to the Authority on estimates of costs, methods of financing, and of time, and legal and other problems involved therein.

THIS RESOLUTION is hereby adopted at Sacramento, California, by the California Toll Bridge Authority this first day of July, 1953.

- -

A P P E N D I X C

PEAK HOUR SOUTHERN PACIFIC TRANSBAY PASSENGERS

Reference is made in this report to the possibility of Southern Pacific going to an all-bus operation across the bridge to carry passengers now handled on the ferries. The following information indicates the probable number of additional buses on the Bay bridge during the rush hours if ferry service is discontinued.

There are three scheduled westbound trains arriving at Oakland Pier during the morning rush, and three eastbound trains leaving Oakland Pier in the evening rush, non-passenger carrying "milk trains" neglected. These trains, their average daily number of passengers, and times of arrival and departure, are listed below:

Westbound Trains Arriving Oakland Pier During Morning Rush Hour

Train Number	Name	Arrive Oakland Pier	Estimated Average Number Transbay Pass.
11	Cascade	8:25 AM	135
101	City of S.F.	8:31 AM	160
247	El Dorado	9:13 AM	60
		Total	355

Eastbound Trains Leaving Oakland Pier During Evening Rush Hour

Train Number	Name	Leave Oakland Pier	Estimated Average Number Transbay Pass.
102	City of San Francisco	5:37 PM	160
12	Cascade	5:43 PM	135
248	El Dorado	6:04 PM	60
		Total	355

Assuming these passengers and their baggage are carried across the Bay by bus, with an average of 35 persons per bus, the Southern Pacific passenger movement would result in about 10 additional buses on the bridge per hour in the direction of maximum traffic flow during the morning and evening peak periods.

The only important westbound train during the evening peak is the California Zephyr of the Western Pacific, which has an arrival time of 4:50 PM in San Francisco. Lacking passenger data, it is assumed transbay passengers on this train could be carried by not more than six buses.

The following sets forth data regarding eastbound trains leaving Oakland Pier during the morning rush hours:

Eastbound Trains Leaving Oakland Pier During Morning Rush Hour

Train Number	Name	Leave Oakland Pier	Estimated Average Number Transbay Pass.
224	Senator	7:51 AM	42
52	San Joaquin Daylight	8:00 AM	80
10	Shasta Daylight	8:23 AM	265
		Total	387

Assuming these passengers and their baggage are carried across the Bay by bus, with an average of 35 persons per bus, the Southern Pacific passenger movement would result in about 11 additional buses on the bridge in the direction opposite to that of

maximum traffic flow during the morning rush.

There is no data to permit the number of trucks needed to carry mail and express to be estimated, so a figure of 3 trucks in each direction during the peak period will arbitrarily be assumed.

Using the above data, the total number of additional vehicles on the Bridge during the morning rush is as follows:

Buses, westbound	10
Trucks carrying head-end matter, westbound	3
Buses, eastbound	11
Trucks carrying head-end matter, eastbound	3
Total added vehicles, morning rush period	27

For the evening rush period the number of added vehicles would be about 20 or less.

In the event the Southern Pacific is forced to bus operation, either as a consequence of the PUC decision, as the result of economic factors, or due to inability to secure an extension of the Oakland Mole franchise, there is reason to believe the Company would be seriously interested in using a portion of the Bridge Railway terminal, if it has been converted to accommodate buses, as the San Francisco main line terminal for all passengers destined across the Bay. In this case Western Pacific would be forced to follow suit.

However, if the Bridge Railway terminal has not been converted to bus and the transfer is to be handled by bus operation then Southern Pacific and Western Pacific would have to find or construct some other suitable terminal.

COMPARATIVE SPECIFICATIONS FOR RAILWAY ROLLING STOCK

Item	Existing Units (87) With Present Equipment	Existing 23 - Bethlehem-Built Cars: Rewired With FS-2 Field Taps	Existing 23 - Bethlehem-Built Cars: As Modified With Additional Power Truck & New Gears	New Type Cars - St. Louis Car Co.: Used on Boston, Chicago, and Cleveland Rapid Transit Systems	New Type Cars - St. Louis Car Co.: Proposed Modifications To Adapt For Bay Bridge Use
Arrangement	Articulated unit with three trucks	Articulated unit with three trucks	Articulated unit with three trucks	Two cars semi-permanently coupled together	Two cars semi-permanently coupled together
Overall Length	110 ft.	110 ft.	110 ft.	2 at 48 = 96'	2 at 48 = 96'
Overall Width	8'10"	8'10"	8'10"	9'4"	9'4"
Seating Capacity	132 persons (Including 8 on Folding Seats)	132 persons	132 persons	98 persons (Not including Folding Seats, if any)	114 persons
Doors, Number	4	4	4	8	4
Maximum balancing speed on level tangent track	38 mph	46.5 mph	58 mph or more	46 mph	55 mph or more
Maximum speed on 3% grades	20.5 mph	22.8 mph	32.4 mph	40 mph	51 mph
Number of Motors	4	4	6	8	8
Total Horsepower	440 HP	440 HP	660 HP	440 HP	700 ± HF
Gear Ratio	3.05 to 1	3.05 to 1	2.26 to 1	7.17 to 1	———
Weight Empty	138,890 lbs	138,890 lbs	145,000 lbs	2 at 45,000 = 90,000 lbs	2 at 50,000 = 100,000 lbs
Weight Loaded (No standees)	159,000 lbs	159,000 lbs	164,000 lbs	2 at 52,000 = 104,000 lbs	2 at 57,000 = 114,000 lbs
Estimated Cost, per 2-car unit	---	$5,000 for rewiring	No data $20,000 Est.	$80,000	$120,000

APPENDIX E

LOCATION OF SAN FRANCISCO INTERURBAN LOOP AS RECOMMENDED IN 1927

(The following is extracted from "Report of Board of Engineers, Transbay Bridge, San Francisco", May 1927. Report of Board Consisting of Robert Ridgway, Arthur N. Talbot, and John D. Galloway, to Board of Public Works, M. M. O'Shaughnessy, City Engineer)

"Interurban Train Traffic. Passengers making up this traffic are mostly those who live in the East Bay cities and work in San Francisco. They form the westward peak load in the morning and the eastward one in the evening, and their convenience should therefore be considered in planning for interurban train traffic. In the strict sense of the word, there should be no San Francisco terminal for interurban trains. That would mean landing and taking on passengers at but one point, as is now done at the Ferry Depot, and would cause congestion and delay. Furthermore, to bring all of the passengers to one point would require most of them to ride further on a street car or to walk long distances. A better solution is to extend the train service through the delivery district by means of an elevated or subway line with stations at frequent intervals, so that the passengers may be carried to points nearer their destination. With several stations the traffic would not be concentrated at one place and could be handled in a more orderly way.

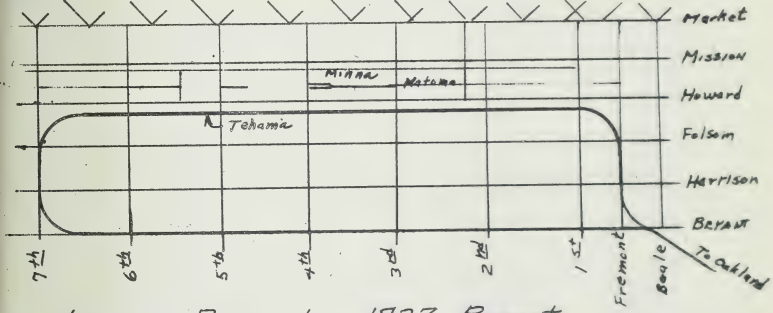
"Applying these principles to selected Location No. 1, it is proposed to build a two track elevated loop from the terminus of the bridge proper on Rincon Hill on the following route: northward on Fremont Street to a point near Folsom; thence by a long curve into Tehama Street; thence west on Tehama Street and private property to Seventh Street; south on Seventh Street to Bryant Street, and east on Bryant to a connection with the bridge approach on Rincon Hill at First Street.

"The turns from street to street will be by means of curves of sufficiently long radii for efficient operation. The elevated structure to be high enough to afford ample overhead clearances for street cars and vehicles, as well as freight cars on those streets where there is steam railroad operation.

"The structure would have a solid floor and would be so designed as to minimize noise and other objectionable features. Two and possibly three passenger stations would be so located along Tehama Street that passengers would not have to walk more than one block along that street to enter one of them. These stations would be much nearer the center of the business and shopping district than is the present Ferry terminal. Similar stations would be located at convenient points on Bryant Street. The train platforms would be of ample length to accommodate the longest interurban trains.

"The routing described is a tentative one and may be modified or the loop greatly expanded, if further study should indicate the advisability of doing so.

"As stated elsewhere in this report, the tracks may be connected with any system of rapid transit, elevated or subway, that the city will find it necessary to build at some time in the future."



Loop as Proposed in 1927 Report

(Note: The Tehama Street location mentioned above is south of and extends parallel to the Minna-Natoma Street location discussed in this report).

APPENDIX F

RECENT RECORD OF KEY SYSTEM TRANSIT ON BAY BRIDGE

			Percent Loss
June, 1954		June, 1953	
Trains, Toll Paying		721,170	
Buses		510,075	
YBI Trains and Other Gov't Toll Free		125,258	
Total		1,356,503	
May, 1954		May, 1953	
Trains, Toll Paying	530,112	734,327	
Buses	368,945	510,633	
YBI Trains and Other Gov't Toll Free	99,021	125,203	
Total	998,078	1,370,163	-27.2%
April, 1954		April, 1953	
Trains, Toll Paying	547,041	744,781	
Buses	392,741	528,909	
YBI Trains and Other Gov't Toll Free	101,527	146,367	
Total	1,041,309	1,420,057	-26.7%
March, 1954		March, 1953	
Trains, Toll Paying	574,845	778,772	
Buses	409,531	543,958	
YBI Trains and Other Gov't Toll Free	110,149	143,137	
Total	1,094,525	1,465,867	-25.3%

APPENDIX F (Continued)

RECENT RECORD OF KEY SYSTEM TRANSIT ON BAY BRIDGE

February, 1954		February, 1953	Percent Loss
Trains, Toll Paying	518,492	689,384	
Buses	355,916	481,365	
YBI Trains and Other Gov't Toll Free	113,710	136,547	
Total	988,118	1,307,296	-24.4%
January, 1954		January, 1953	
Trains, Toll Paying	527,759	749,505	
Buses	368,800	525,230	
YBI Trains and Other Gov't Toll Free	129,699	139,256	
Total	1,026,258	1,413,991	-27.4%
December, 1953		December, 1952	
Trains, Toll Paying	590,735	778,541	
Buses	406,810	540,144	
YBI Trains and Other Gov't Toll Free	125,340	133,183	
Total	1,122,885	1,451,868	-22.7%
November, 1953		November, 1952	
Trains, Toll Paying	586,855	748,071	
Buses	397,356	490,742	
YBI Trains and Other Gov't Toll Free	118,957	145,687	
Total	1,103,168	1,384,500	-20.3%
October, 1953		October, 1952	
Trains, Toll Paying	442,570	813,712	
Buses	319,318	571,397	
YBI Trains and Other Gov't Toll Free	81,463	155,520	
Total	STRIKE	1,540,629	
September, 1953		September, 1952	
Trains, Toll Paying	0	772,213	
Buses	0	530,513	
YBI Trains and Other Gov't Toll Free	0	156,246	
Total	STRIKE	1,458,972	
August, 1953		August, 1952	
Trains, Toll Paying	0	800,644	
Buses	0	538,414	
YBI Trains and Other Gov't Toll Free	0	153,777	
Total	STRIKE	1,492,835	
July, 1953		July, 1952	
Trains, Toll Paying	566,691	816,730	
Buses	385,597	562,720	
YBI Trains and Other Gov't Toll Free	89,190	139,594	
Total	STRIKE	1,519,044	
June, 1953		June, 1952	
Trains, Toll Paying	721,170	802,899	
Buses	510,075	547,025	
YBI Trains and Other Gov't Toll Free	125,258	149,890	
Total	1,356,503	1,499,814	-9.6%

APPENDIX G

DESCRIPTION OF ALTERNATIVE MEANS OF REDECKING BRIDGE

In Part IV it is stated that a number of different alternative studies other than the one selected as most desirable were made with regard to the possibility of reconstructing the Bay Bridge to provide for 100 percent vehicle operation. These are described below:

Conversion of Lower Deck to Five Lane Unobstructed Roadway

The bridge as now constructed has no structural dividing members between the railway portion and the roadway portion of the lower deck on the main over-water crossings. However, on the San Francisco approach viaduct, the Island viaduct and tunnel crossing, and on the East Bay approach the railway portion of the lower deck is separated from the roadway by numerous concrete supporting members. The total length of these viaducts, etc., is about one-half mile.

It would be possible to remove the various supporting walls and columns and to substitute a structural steel supporting system for the upper deck to replace the removed supporting members. This scheme would involve difficult and costly construction under traffic, but has the advantage of a somewhat higher traffic capacity as compared with other proposals.

In the tunnel the grade of the truck roadway would be lowered about 2-1/2 feet to maintain a minimum vertical clearance of 16 feet for commercial vehicles. All of this grade revision could be accomplished within that portion of the lower deck roadway which is now founded on natural ground. Although this plan does have advantages in facilitating the movement of traffic in making for more flexible vehicle operation if all train service is discontinued, it is not recommended because of the high cost of performing the work outlined above. The additional cost of work on the Island alone as compared with the plan described in Part IV would be about $2.5 million.

Strengthening of Upper Deck

Studies were made of the feasibility of strengthening the upper deck, which was originally designed for passenger vehicles only, to carry legal highway loading. The upper deck would be converted to five lanes and the slab, stringers, and floor beams would be strengthened to support the AASHO H20-S16 loading. In conjunction with this plan the lower deck would also be reconstructed, as outlined above, to provide a five-lane unobstructed roadway. Thus, the upper deck would carry five lanes of mixed traffic in one direction and the lower deck would carry five lanes in the opposite direction.

The present design of the decks is outlined below:

Upper Deck
Slab - Lightweight concrete on west bay suspension spans and east bay spans. Regular concrete on Yerba Buena Island.
Stringers - Carbon steel on suspension spans. Silicon steel on the remainder of the structure.
Floorbeams - Silicon Steel.

Stringers in the upper deck are designed for H13 1/3 loading. Floorbeams are designed for 4 center lanes of H10 and 2 outside lanes of H13 1/3.

Lower Deck
Slab - Regular concrete.
Stringers - Both carbon and silicon steel, varying throughout the structure.
Floorbeams - Silicon steel.

The lightweight concrete slab and steel stringers can in general be strengthened by placing intermediate stringers. Stringers will have to be attached to the floorbeams by drilling and riveting. None of the silicon members can be strengthened by welding since no satisfactory procedure for welding this material has been developed.

Silicon steel floorbeams can be strengthened by placing tension rods below the lower flange. Some interference by the upper deck gantry rails would occur. However, the gantry system could be revised to accommodate the floorbeam strengthening.

At Yerba Buena Island the existing concrete beams would be strengthened by supporting them with an independent system of steel members. It would not be necessary to remove the existing slab and beams in the tunnel or viaducts, as their weight could be transferred to the steel system under traffic. Although this would be a difficult and costly operation, it would eliminate any interference with upper deck traffic.

At the San Francisco viaduct and "on" and "off" ramps the estimate for this plan only covers the addition of supplementary concrete columns and beams. For a large part of the approach viaduct it is single story, and columns could be placed between the existing. The problem of appearance arises and should be given further consideration when and if the strengthening is done.

Estimate of Cost

Strengthen the present upper deck to carry 5 lanes of H20-S16 loading. Remove railway tracks and pave railway portion. Remove center columns from tunnel and viaduct on Yerba Buena Island.

San Francisco Viaduct, Fremont and First Sts. on and off ramps, San Francisco Anchorage	$1,260,000	
San Francisco Anchorage to Yerba Buena Island	3,100,000	
Yerba Buena Is. Tunnel & Viaducts	3,400,000	
Yerba Buena Island to Pier E39	3,400,000	
	$11,160,000	$11,160,000
Remove tracks	*638,000	
Place concrete deck over railway portion on lower deck	4,200,000	
Electrical work (revision of roadway lights, revise conduits)	*1,854,000	
	$6,692,000	6,692,000
		$17,852,000
10% Contingencies		1,785,200
Cost		$19,637,200

The limits for the work in Plan I are between the 5th St. entrance in San Francisco and Pier E34 on the East end. Rights of way revision of toll plaza, marginal refuge bays, purchase of buses, etc., not included.

Conclusions

The proposal for operating heavy trucks over the upper deck of the Bay Bridge introduces an element of structural risk which cannot be ignored. The upper deck of the Bay Bridge consists of a thin, lightweight concrete slab supported on steel stringers and designed for passenger car loads only.

As compared with ordinary concrete, lightweight concrete is a relatively fragile material. On some other bridges where truck traffic has operated over lightweight concrete flooring, serious spalling and loosening of the mortar topping has occurred. If such spalling and cracking should occur on the Bay Bridge upper deck, complete removal and replacement with regular concrete might become necessary. This would be both costly and extremely difficult to accomplish under traffic. Moreover, it would seriously increase the dead weight of the bridge, with consequent increases in cable stresses.

It is evident no plan for reconstruction of the Bay Bridge can be given serious consideration if it poses a threat of possible future major repairs which would necessarily impede the flow of traffic between the two sides of the Bay.

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*Division of Bay Toll Crossings figure, 1949

For the foregoing reasons and considering also the comparatively high cost, this plan for strengthening of the upper deck to carry trucks and buses is definitely not recommended.

Temporary Asphaltic Surfacing Over Rails

It has been suggested that the rails be retained on the bridge, and that some sort of temporary asphaltic surfacing be placed around and between the rails to permit use of the space by vehicles. Since safety considerations and the comparatively steep grades on the bridge would prohibit mixing trains and rubber-tired vehicles on the same roadway, use of the trains would have to be discontinued.

This scheme has little merit because of the numerous disadvantages; namely:

1. The Bridge Railway ties do not have sufficient strength to support legal truck loads or overloads operating on such a pavement without serious over-stress.

2. Such repaving would make the timber track structure inaccessible in event of fire.

3. An asphaltic surfacing might accelerate decay of the ties.

4. Where the rails are on curves, the super-elevation of the two tracks, each in a different plane, would require difficult construction to permit the installation of a highway pavement with the super-elevation all in one plane.

5. Because of the steel rails buried in the asphaltic surfacing, it would be extremely difficult to maintain a level or even roadway under heavy bus and truck traffic. The presence of the rails in the pavement would tend to encourage rutting of the pavement.

Because of these numerous disadvantages, detailed study of the scheme for repaving with asphaltic surfacing, leaving the existing rails in place, is not warranted.

Intermediate or Mezzanine Deck

In this plan the tracks would be repaved and an intermediate or mezzanine deck would be constructed between the upper and lower decks, above the space now occupied by the rails, thus resulting in a partial triple deck structure. The bridge as thus

reconstructed would provide six lanes for private passenger automobiles on the upper deck; two lanes for passenger automobiles on the mezzanine deck, this deck being reversible; and on the lower deck two lanes underneath the mezzanine deck and three lanes for commercial traffic on the present truck roadway. Vertical clearance on the two new two-lane decks to be constructed in the space now occupied by the rails would be seriously impaired, with only about 9 feet between the deck and overhead.

This plan was not investigated in detail because of the numerous obvious disadvantages, namely, 1) this scheme does nothing to improve the lower deck connections at the Island, 2) the difficulty of providing ramp connections to permit reversible flow of traffic at the two ends of the bridge, 3) the natural reluctance of drivers to operate several miles over a roadway which provides only about 9 feet of overhead clearance, 4) the difficulties of painting, and 5) this scheme does nothing to increase the capacity of the bridge for commercial vehicles.

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